TROPICAL AGRICULTURE

January to December, 1930.

TRINIDAD:
PRINTED BY THE GOVERNMENT PRINTER,
GOVERNMENT PRINTING OFFICE,
PORT-OF-SPAIN.

1930.

TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. VII No. 1. JANUARY, 1930. PRICE 6d.

CONTENTS.

	PAGE.
West Indian Agriculture	1
Colonial Appointments	2
Pan Boiling II	3
Trinidad and Java Cacao	9
Cocoa Moulding	12
Citrus Products Industry	13
Cotton Notes	16
West African Conference	18
A Novel Experiment Station	18
Soil Erosion	19
Ground-Nuts	20
Artificial Manuring of Paddy	21
Cane cutting machine	21
Tropical World Notes	22
Entomological Notes	23
1930 Poultry Congress	23
Sugar Notes	24
Chemical Notes	25
Obituary Notice	26
College News	26
Agricultural Excursions	27
Appointments	27
Visit of Sugar Commission	27
Review	27
Trend of the Markets	28

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2483.

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

WEST INDIAN AGRICULTURE.

Conference of Directors of Agriculture.

AGRICULTURAL progress was a matter that received close attention at the second Standing Conference of the West Indies that was held in Barbados in January, 1929. After considerable discussion this Conference passed a resolution to the effect that greater co-operation was needed between the Agricultural Departments of the Conference Colonies and recommended that each of the Governments of the Conference Colonies should appoint its Director of Agriculture, or failing him, an agricultural officer to attend a meeting to be held at an early date under the Chairmanship of the Principal of the Imperial College of Tropical Agriculture. This meeting was to discuss means of co-ordinating programmes of agricultural and veterinary research work, avoiding overlapping between the Agricultural Departments of the various Colonies and maintaining close contact between the local Departments and the Imperial College. This resolution received the approval of the Secretary of State for the Colonies and instructions were accordingly issued that a Conference on the lines suggested should be held at Trinidad.

The dates of this Conference have now been fixed for 23rd January to 29th January, 1930 inclusive and the meeting will take place at the Imperial College in Trinidad when the Directors of Agriculture of British Guiana, Trinidad, Barbados and Bermuda, with agricultural officers from the Windward and Leeward Colonies will be present, and will have the opportunity of discussing agricultural matters with the officers of the College. These Colonies have submitted their programmes of research and experimental work, and Jamaica, which unfortunately will not be represented, has also submitted a programme. British Honduras and the Bahamas do not as yet possess definite agricultural departments, but both Colonies have expressed their approval of the principles involved in the Conference.

An examination of the programmes submitted, with a view to avoiding duplication and unnecessary overlapping, will be the first task of the Conference. There has perhaps been a tendency in the past for each Department to evolve a programme without paying due regard to the work of its neighbours. In this respect it may be possible to find means to allocate

problems on certain crops to particular Colonies which appear to afford peculiar facilities for the prosecution of the work, and the results so obtained might be rendered available to the rest by means of news bulletins or by an interchange of visits of officers.

Another aspect that has to be considered is the relation of the Imperial College to the Agricultural Departments. The research programme of the College naturally includes several important West Indian crops such as sugar-cane, cacao, limes and bananas, these crops being in the main used as suitable "indicators" for the problems that are being investigated. The functions of the College as a Research Station are clearly laid down in the *Lovat Commission's Report* of 1927-28. Fundamental and long range research, which is beyond the normal capacity of an Agricultural Department is to be undertaken. Two of the subjects put down for discussion in the agenda illustrate the point particularly well. Genetic research involving cytological problems is being undertaken by the Botanical Department of the College, and the three crops it is proposed to utilise as "indicators" are bananas, sugar-cane and cacao. The work on bananas has been progressing for several years past, and the programmes for sugar-cane and cacao have been definitely approved by the Board of Governors although a start has only just been made on these crops. The research in sugar-cane breeding in particular is of interest to many of the Colonies, and the Conference will give the Professor of Botany a chance of explaining to his co-workers in the Agricultural Departments how the College researches are likely to fit in and benefit the empirical methods that have, at present, for want of knowledge of the genetic constitution of the canes used for breeding, to be used by the regular cane breeding stations.

Soil research, which is also to be included in the discussion, is another illustration of the necessity for a clear understanding between the Departments and the College. The researches of the College Department of Chemistry and Soil Science have already led to important results. The study of Plant Ecology, initiated by Professor Hardy, has brought out the intimate connection between the health of the plant involving its resistance to disease and pests, and the condition of the soil and the environment in which it grows. Soil surveys designed to throw light on these matters are an urgent necessity. In British Guiana, where new colonization schemes are in progress, the matter is a vital one, and in the other Colonies there is ample evidence that in the past crops have often been planted under conditions quite unsuited to their requirements. The methods evolved by the College have already been applied to Trinidad and it is obviously desirable that ways and means should be found to extend the survey to other Colonies as quickly as possible.

A critical examination of the plant quarantine rules and important regulations can but be productive of good results. It is possible that means may be found to check the further spread of diseases such as gummosis in cane, witch-broom in cacao and the Mediterranean fruit fly in citrus, to mention a few only of the new diseases and pests that are threatening the crops of these Islands.

The final subject of the agenda concerns the incipient trade in fruit and vegetables with Canada. The arrival of the fine steamers of the Canadian National Marine and the regularity of this service has stimulated growers of these products, but the situation is full of difficulties and requires careful organization from the start. There is a tendency for each colony to organize its trade in these products irrespective of the plans of its neighbours. No real progress can be expected unless co-operation can be secured, and a definite understanding arrived at as regards grading, packing, and quality. Definite varieties will need to be evolved to suit the trade and carefully conducted experiments in the cultivation of these crops carried out by the various departments. Storage problems are already arising and low temperature research will be required in both to find out the optimum conditions for transport to the Canadian markets. In this connection the storage conditions on board ship are equally as important as the arrangement made by the producers ashore. The appointment of an officer to co-ordinate these matters is indicated.

Enough has been said to indicate that this Conference has very important work ahead of it. The West Indian Colonies are poor, they are unfortunately small individually and although they are almost entirely dependent for their prosperity on agriculture, they cannot afford large staffs of experts. If they are to succeed they will have to pool their resources in this respect and the object of this Conference is, in effect, to make the first move towards securing this necessary co-ordination of the agricultural research activities in this area.

COLONIAL APPOINTMENTS.

THE following appointments and transfer have been made during the month of September, 1929, by the Secretary of State for the Colonies:—

Mr. J. D. Gillespie, Agricultural Superintendent, British Guiana.

Mr. A. Foggie, Assistant Conservator of Forests, Cyprus.

Mr. A. J. Fyfe, Assistant Conservator of Forests, Federated Malay States.

Mr. R. V. H. Porter, Assistant Conservator of Forests, Kenya (re-allocated from Nigeria).

Mr. P. W. T. Boughton-Leigh, Superintendent of Agriculture, Nigeria.

Mr. J. D. Martin, Assistant Conservator of Forests, Rhodesia.

Mr. C. M. Harris, Assistant Conservator of Forests, Uganda.

Mr. E. MacDonald (Assistant Conservator of Forests, Sierra Leone), Conservator of Forests, Sierra Leone.

PAN BOILING—II.

Its Scientific Control and the Zeiss Industrial Refractometer.

By S. J. Saint, B.Sc., A.I.C.,
Department of Science and Agriculture, Barbados.

During the crop season of 1928 an investigation was made of the applicability of the Zeiss Industrial Refractometer to the scientific control of the boiling of sugar-cane syrups (1). This investigation has been continued and extended at Carrington Factory, Barbados, during the past crop season.

1. The Industrial Refractometer and the Boiling of Cane Syrups.

The three strike system of boiling sugar (Geerligs "Absolute Recovery" process) is adopted at Carrington Factory. The apparent purity of the three massecuites are kept approximately at 80°, 70° and 55°.

The methods which the pan boiler used in dealing with these strikes were followed carefully and data concerning concentration, purity, temperature and vacuum were recorded. The refractometer was attached low down in one of the vacuum pans so that at any time, under practical boiling conditions, the concentration of the mother liquor in the pan could be determined. Samples of massecuite were obtained at different stages of the boiling and samples of mother liquor were separated from the massecuite. Analyses were carried out on both massecuite and mother liquor samples. The methods which were used for rapidly taking samples of massecuite from the pan and for separating samples of mother liquor were evolved as the result of the experience gained in the crop season of 1928 and of subsequent discussions with the manager and chemist of Carrington Factory. The method of taking massecuite samples is illustrated in Fig. 1. A bell jar containing two tubulars was arranged so that one tubular could be connected to the vacuum supply and the other to a ¾-inch pipe which had been screwed in low down on the pan. The opening of a stop-cock on the vacuum pipe evacuated the bell jar and the opening of a stop-cock on the other pipe permitted massecuite to flow by gravity from the pan into a suitable receptacle previously placed under the bell jar. It was found that even highly concentrated low purity massecuites could be sampled rapidly by this method.

The mother liquor sample was separated from a portion of the massecuite sample by filtering through a very fine mesh copper gauze. The gauze was tied over the mouth of a buchner funnel and the stem end of the funnel was connected to the vacuum line. The covered mouth of the funnel was then pushed into the massecuite and, in this way, an adequate sample of mother liquor could be separated with considerable speed. No fine grain could be detected when the mother liquor was examined under the microscope even in the case of the molasses obtained from the low purity massecuites.

In the samples of massecuite and mother liquor, true sucrose was determined by the method of Jackson and Gillie (2) and the dry matter was determined with the hand refractometer at a 1 : 1 dilution. In certain cases dry matters were also determined by drying. From these determinations the optical purities were calculated and the coefficients of supersaturation of the mother liquor were found by means of the optical purity and the refractometric dry matter. These coefficients are higher than the true values and will be termed 'apparent' coefficients of supersaturation to distinguish them from "true" coefficients of supersaturation calculated from true dry matter and true purity. For the purpose of calculating tables for use with the industrial refractometer which indicates the refractometric dry matter of the mother liquor and not the true dry matter, it is preferable to use the 'apparent' coefficient of supersaturation. The optical purity from which the 'apparent' coefficient of supersaturation is calculated can be determined more readily and rapidly than the true purity and as long as the 'apparent' coefficient is used only for calculating tables for use with the refractometer, no error is introduced.

Calculations based on the analytical determinations and recorded data showed that the boiling of the A and B strikes were carried out in a similar manner to the boiling of corresponding strikes at Sandy Lane Factory. Similar coefficients of supersaturations of the mother liquor were maintained.

The results of the two seasons' work show that the practical pan boiler maintains an 'apparent' coefficient of supersaturation of 1.15 for A strikes and 1.2 for B strikes. The calculation of tables for the boiling of A and B strikes with the aid of the refractometer can therefore be based on these supersaturations.

In the case of the C or final low purity strike, the pan boiler at Carrington Factory adopted a somewhat different method to that used by the pan boiler at Sandy Lane Factory. After the introduction of molasses the 'apparent' coefficient of supersaturation was raised to 1.2 as at Sandy Lane Factory and the boiling was identical up to about 60 per cent. of the striking volume of the pan. The pan boiler at Carrington Factory then proceeded gradually to raise the concentration of the massecuite until at a height of about 80 per cent. of the striking volume the 'apparent' coefficient of supersaturation of the mother liquor had been raised to 1.35 and at a height of 100 per cent. the supersaturation reached 1.45. This figure is equivalent to a true supersaturation of the mother liquor of 1.25 and corresponds to a concentration of about 96° Brix for the massecuite. This was the desired concentration for striking the massecuite so that after the pan had been filled

very little time was spent in further concentration. At Sandy Lane Factory, the pan boiler operated the pan for the C strike so that the apparent coefficient of supersaturation of the mother liquor remained at 1.2 until the pan was full. The further entry of molasses was then stopped and the massecuite was concentrated until the mother liquor had an 'apparent' coefficient of supersaturation of 1.35 which corresponded to a concentration of about 93° Brix for the massecuite.

There is no doubt that the method of dealing with the low purity strike adopted at Carrington Factory is superior to the method adopted at Sandy Lane Factory. This is well brought out in Table I where the purities of the mother liquor at corresponding purities of the massecuite are compared.

TABLE I.

	Sandy Lane Factory.		Carrington Factory.	
Optical Purity of Massecuite.	Optical Purity of Mother Liquor.	Apparent Coefficient of Supersaturation.	Optical Purity of Mother Liquor.	Apparent Coefficient of Supersaturation.
67.5	57.5	1.21	52.5	1.26
65.0	56.5	1.19	49.8	1.35
63.0	56.0	1.24	48.2	1.45

It is seen that the result of increasing the coefficient of supersaturation of the mother liquor has resulted in a considerable decrease in the purity with a corresponding increase in the amount of crystal sucrose in the massecuite. It should be noted that there was no sign of false grain as the result of increasing the supersaturation. It has already been pointed out that an 'apparent' coefficient of supersaturation of 1.45 in the mother liquor under consideration corresponds to a true coefficient of supersaturation of 1.25. As will be shown later, spontaneous crystallisation of a high purity cane syrup takes place in the absence of sucrose crystals at an 'apparent' supersaturation of 1.33 to 1.35; at the purity of the syrup this will be almost equivalent to the true supersaturation. It is therefore highly probable that in the low purity mother liquor of a C strike and in the presence of sucrose crystals, spontaneous crystallisation will take place at a higher supersaturation than 1.35. It would appear then that the method of boiling low purity strikes adopted at Carrington Factory is capable of further extension. The true coefficient of supersaturation of the mother liquor of the low purity strike could be safely raised to 1.35 before striking into the crystalliser. This will result in a considerably greater extraction of sucrose from the final molasses. The ordinary pan boiler who has to judge the concentration of the massecuite by eye is very chary of raising the concentration because if he makes a mistake false grain may form, and he is therefore inclined to keep the massecuite too thin. With the aid of the refractometer it is possible to determine the concentration of the mother liquor accurately at any stage of the boiling process so that the supersaturation of the mother liquor could be raised with safety. There need be no fear of false grain formation if care has been taken to allow a sufficient number of crystals to form during the graining process.

The work which has been carried out at Carrington Factory on the boiling of cane juices confirms the preliminary investigations which have been already described ([1]). This paper should be consulted for detailed particulars of how to construct tables for use with the refractometer in the boiling of cane syrups.

2. The Industrial Refractometer and the Graining of Cane Syrups.

The work which has been so far described has demonstrated that the industrial refractometer can be successfully used in conjunction with tables by any intelligent person for the purpose of controlling the boiling of cane syrups in a vacuum pan. It has been assumed that crystals of sucrose are present in the pan in sufficient numbers and the problem has been one of maintaining the optimum concentration of the mother liquor surrounding the crystals.

The process of forming sucrose crystals from syrups—the graining process—is as important a part of the art of pan boiling as the subsequent growing of those crystals. If therefore the industrial refractometer is to be successfully applied to pan boiling it is equally necessary to show that the refractometer can be used to control crystal formation.

The two chief objects to be aimed at in grain formation are: (1) that the size of the crystals shall be as uniform as possible in order to facilitate the separation of the molasses in the centrifugals, and

(2) that the crystals should be present in optimum numbers. If crystals are formed in insufficient numbers, the area of crystal surface exposed to the supersaturated mother liquor will be too small and sucrose will probably come out of solution as fresh crystals during the boiling process. On the other hand if too many crystals are formed, a very fine grain massecuite will result. In both cases difficulty will be met with in separating the molasses at the centrifugals.

(1) *The Uniformity of the Grain Size.*

The method of graining adopted by pan boilers in Barbados is usually described as the "waiting" method. The syrup is concentrated in the pan until the supersaturation of the syrup becomes so great that crystals form spontaneously. The concentration of the syrup is continued until a sufficient number of crystals are judged by eye to be present. The supersaturation of the syrup is then reduced by a charge of dilute syrup so that fresh crystals cease to form.

PAN BOILING II.

(*See page 3.*)

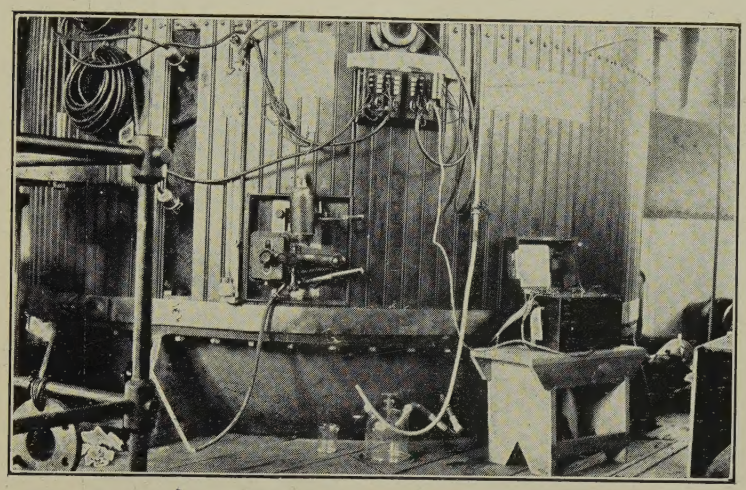


FIG. 1.—*Showing Refractometer attached to Pan and method of sampling Massecuite.*

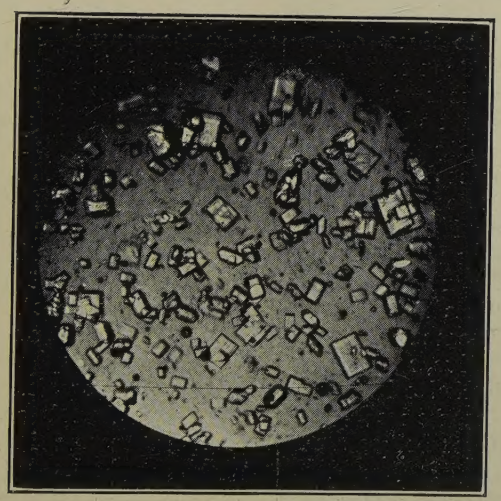


FIG. 2.—*Grain formed by "waiting" method. Time of formation=ten minutes.*

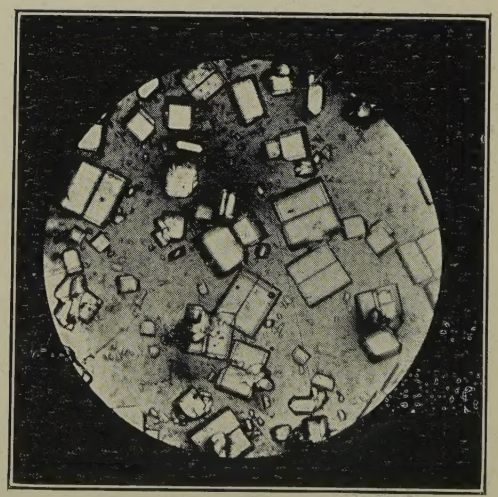
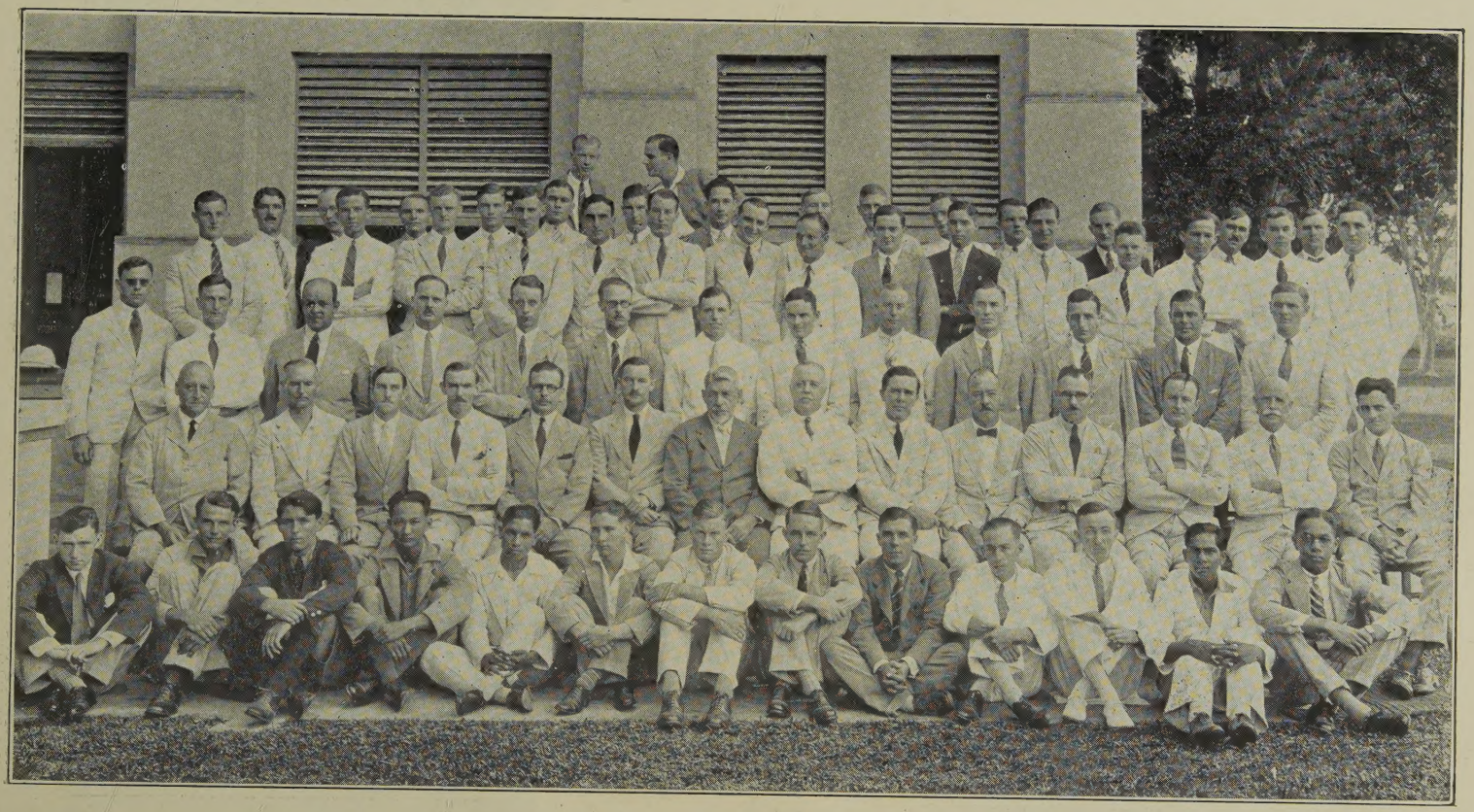


FIG. 3.—*Grain formed by "waiting" method. Time of formation=20 minutes.*

ACADEMIC STAFF AND STUDENTS, 1929-30.



Sitting on Ground J. E. Mill, G. B. Gregory, H. L. Manning, E. S. A. Chin, C. K. Robinson, J. L. A. Goellnicht, V. A. Pope, A. C. Packer, E. Laurence-Trott, J. M. Cave, J. F. Williams, Jenarine Singh, S. A. Schouten.

Second Row F. W. Urich, H. W. Simmonds, C. W. Wardlaw, E. E. Cheesman, W. Scott, H. R. Briton-Jones, H. A. Ballou, G. Evans, F. Hardy, R. C. Wood, C. Y. Shephard, E. A. Seagar, A. G. Howell, C. T. Watts.

Third Row F. B. Notley, R. E. Hunter, H. V. M. Metivier, L. A. Corbin, P. E. Turner, A. Pickles, H. H. Croucher, G. Gianetti, D. H. Brown, A. K. Briant, J. G. Davies, J. Steele, B. A. Lowe.

Fourth Row G. Griffith, R. J. A. W. Lever, H. L. Grogan, C. A. S. Hynam, G. W. Lock, C. G. Akhurst, A. F. Nichols, N. R. Fuggles, J. B. G. Savory, J. A. Wirshing, R. Johns, C. A. Thorold, D. H. I. Searle, G. Des Grottes, E. G. A. Benson, H. L. G. Milne, J. R. Curry, S. T. Hoyle, A. J. Kerr, A. B. Stark, J. West, L. L. de Verteuil, H. D. Leighton, I. C. Young, G. M. Roddan, R. P. Davidson, L. C. W. Greaves, J. L. Scott, E. O. Pearson, H. McLuskie, J. P. Maule.

It is evident that a perfectly regular grain cannot be obtained by this method since the formation of crystals must occupy a definite time period. It also follows that the longer this time interval is, the greater will be the differences in size between the first formed and the last formed crystals. During grain formation the syrup has a high supersaturation and the first formed crystals will increase in size rapidly since the velocity of crystallisation increases rapidly with supersaturation ([5]). The deposition of sucrose as new crystals or on the surface of crystals already formed will tend to reduce the supersaturation of the syrup, and the concentration of the syrup must therefore be carried out as quickly as possible so that the supersaturation of the syrup is not only maintained but rapidly increased.

A good example of the effect of time of graining on uniformity of crystal size in the "waiting" method of graining was afforded by the methods adopted at Sandy Lane and Carrington Factories. At Carrington Factory graining for a C strike was carried out with direct steam and between eight and ten minutes elapsed from the time the first crystals formed until graining ceased. The result was a fairly regular crystal size and the massecuite built on this grain gave little trouble at the centrifugal. At Sandy Lane Factory, back pressure steam was used to grain the syrup and the formation of sufficient crystals for a C strike occupied at least 20 minutes. The crystals so formed were very irregular in size and the massecuite built on this grain was often difficult to cure. The photographs given in Figs. 2 and 3 illustrate examples of a fairly regular and a very irregular grain obtained by the "waiting" process.

From both the theoretical and practical aspects, therefore, the "waiting" process of graining must be regarded as a very poor method. The reason why this method is so generally adopted by pan boilers would appear to be due to the fact that no skill is needed. The syrup actually grains itself and the pan boiler only needs sufficient experience to be able to judge when a sufficient number of crystals have formed.

In order to obtain a perfectly regular grain it is necessary to induce the syrup to deposit the requisite number of crystals at one and the same time. In order to attain this end a high supersaturation must be formed suddenly in the syrup. The graining process which most nearly fulfils this condition is the method by which the crystallisation is induced in the syrup by suddenly raising the vacuum. The temperature at which the syrup boils is lowered by this reduction in pressure and as the solubility of sucrose decreases with the decrease in temperature, the supersaturation necessarily rises.

If the purity of the syrup has been previously determined then the supersaturation of the syrup can be calculated and followed if the concentration of the syrup and the vacuum prevailing in the pan are known. The concentration of the syrup can be determined with the refractometer, the purity of the syrup is readily found and the vacuum will be indicated by a suitable gauge: the supersaturations existing in a syrup at graining point can therefore be determined.

The supersaturations of graining cane syrups do not appear to have been previously investigated. The "waiting" method of graining adopted by the pan boiler was therefore followed with the aid of the refractometer for various strikes and all the necessary data for calculating the variations in the supersaturations of the syrup were recorded or determined. It was found that when the graining process was followed for the same types of strike the data obtained were very similar. A typical curve showing the variation of supersaturation with time obtained by the "waiting" process for a C strike is shown in Fig. 4. It has been found that with a syrup of an optical purity of 85° to 86°, crystals can first be distinguished under the microscope when the apparent coefficient of supersaturation is between 1.33 to 1.35. Similar figures were obtained at Sandy Lane Factory in some preliminary work on graining carried out there. It can therefore be taken as definitely established that under practical conditions spontaneous crystallisation commences in a syrup of 85° to 86° optical purity at a supersaturation of about 1.35. Reference to the curve in Fig. 4 shows that in graining a C strike the 'apparent' coefficient of supersaturation of the syrup was raised to a maximum of about 1.6. When graining for an A strike in which a smaller number of crystals is needed, the 'apparent' coefficient of supersaturation was raised to a maximum of about 1.5.

If it is assumed that a sufficient number of crystals can be formed for a C strike by suddenly raising the supersaturation to 1.6, then a curve can be drawn showing for a given purity syrup the relationship between concentration and vacuum at this supersaturation. In a similar way it is possible to draw a curve for the supersaturation of 1.3; this is approximately the maximum supersaturation which can be obtained without spontaneous crystallisation. In Fig. 5 curves connecting the vacuum and concentration of a syrup of 85° to 86° optical purity have been drawn for supersaturations of 1.3 and 1.6. With the aid of these curves it is possible to boil the syrup at a high vacuum until the concentration of the syrup indicates that an 'apparent' coefficient of supersaturation of 1.3 has been reached. The vacuum can then be lowered so that at that vacuum and concentration the syrup will have a supersaturation of 1.3 when the concentration of the syrup is sufficiently high to give a supersaturation of 1.6 at the high vacuum. These data can be read off easily from the graph. For instance, assuming that the syrup is boiling at a vacuum of 63.5 cms. then the concentration of the syrup is raised until the refractometer indicates 82 per cent. of dry matter which corresponds to a supersaturation of 1.3. The vacuum is then lowered to 49 cms. and boiling is continued until the refractometer indicates a

PAN BOILING—II.

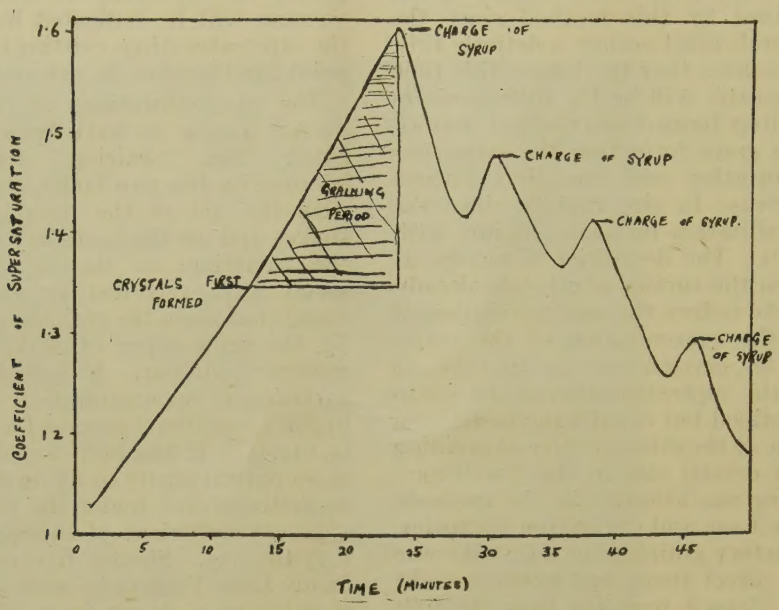


Fig. 4. Showing variation of supersaturation with time in the "waiting" method of graining.

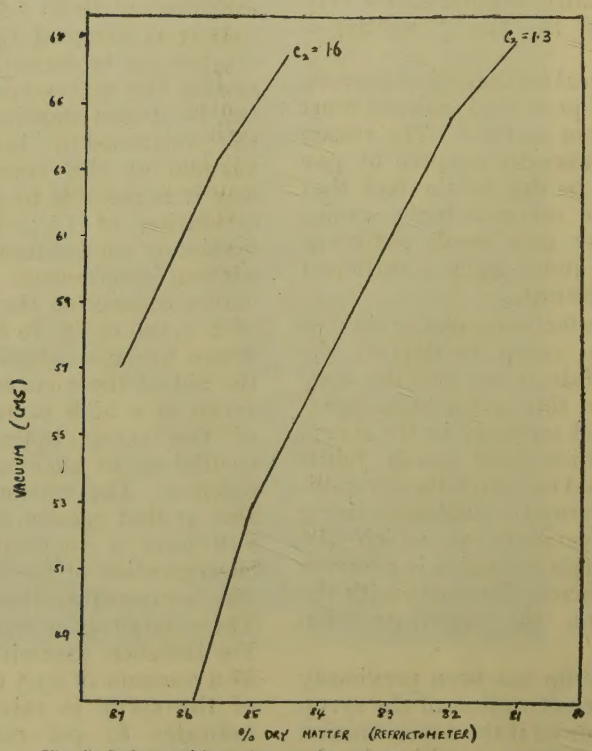


Fig. 5. Relationship between dry matter and vacuum for cane syrups of 86° purity at supersaturation of 1·3 and 1·6

dry matter of 85.5 per cent. At this concentration and a vacuum of 49 cms. the 'apparent' coefficient of supersaturation is 1.3, but at this concentration and a vacuum of 63.5 cms., the 'apparent' coefficient of supersaturation of the syrup is 1.6. As soon therefore as the concentration reaches 85.5 per cent. the vacuum is raised to its original amount. In this way the supersaturation is suddenly raised from 1.3 to 1.6, the syrup boils violently and grain forms throughout the mass of syrup. Further grain formation can be prevented by charging the pan with syrup and reducing the co-efficient of supersaturation to about 1.15.

This method of graining was tried out in practice and yielded a very uniform grain. It is considered that this method is well adapted for use with the refractometer since, in this way, a strict control can be maintained of the supersaturation of the syrup. With the aid of graphs similar to that shown in Fig. 5, the syrup can be raised to that final supersaturation which is found to suit best the local conditions.

(2)—*The Number of Crystals.*

There is no known rapid method of determining the number of crystals in a graining syrup. As already indicated, the essential condition for regularity of grain is rapidity of formation. It therefore follows that no counting method can possibly be satisfactory for controlling actual grain formation. Baldwin ([3]) has patented a device which consists of a microscope fitted into the wall of the pan and means are provided for trapping a known volume of syrup so that an actual count of the number of crystals can be made. It is contended that this device will enable the operator to determine the moment at which the formation of grain should be arrested. It would seem that by the time the grain had been counted, the result would be vitiated by the fact that an unknown number of new crystals had formed during this period. Thieme ([4]) has described a method by which the number of crystals formed during the graining process can be counted under the microscope. This method, however, is not advanced as a means of showing the operator when a sufficient number of crystals have been formed.

It would appear that, practically, there is only time to make a visual estimate of when a sufficient number of crystals have formed during graining. This estimate can be made more exact, as Thieme has suggested, by the preparation of standard tablets which give the density population for known numbers of crystals. The sample drawn from the pan can be compared with these standards.

In the "waiting" method of graining, the practical pan boiler estimates when a sufficient number of crystals have formed by examining a sample of the graining syrup against the light on a plate of glass with or without the aid of a hand lens. The estimate of the pan boiler depends solely on his previous experience and, as will be shown, his estimate is a very approximate one and is probably no more exact than the estimate an intelligent person would obtain with the aid of standard tablets and no previous experience.

The graining for the final low purity strike has been mainly dealt with in these investigations as the efficient boiling of this strike is regarded as the most important and most difficult part of the boiling process. It is very necessary in graining for a low purity strike that a sufficient number of crystals be formed in order that any possibility of false grain formation shall be prevented. The procedure adopted by the pan boiler in order to obtain sufficient grain for the low purity strike will be described. At graining point the syrup occupied approximately 40 per cent. of the striking volume of the pan. As already mentioned, the syrup then had an apparent coefficient of supersaturation of about 1.35 and the concentration of the syrup was continued until the supersaturation was raised to about 1.6. Sufficient grain was then judged to be present and syrup was let into the pan in three or four charges until the supersaturation of the mother liquor had been reduced to 1.15. The crystals were then increased in size by boiling with syrup until the massecuite occupied about 66 per cent. of the striking volume of the pan. Part of the grain was then cut over into two other pans and used for building A or B strikes. The level of the massecuite was thus reduced to about 34 per cent. of the striking volume or such other level as would give, when boiled with the available molasses, the required purity for the final massecuite.

The number of crystals formed by the pan boiler on two occasions for these final low purity strikes were counted by the method described by Thieme. Anhydrous glycerine was used and found preferable to a saturated sugar solution as recommended by Thieme in the dilution of the sample drawn from the pan. The saturated sugar solution is very viscous and is inclined to deposit crystals before the counting can be carried through. The figures which were obtained for the two C strikes have been calculated to express the number of crystals in 1cc. of the massecuite at striking point on the assumption that no fresh crystals formed after the initial graining process finished. The results gave 133,000 crystals per cc. in the one case and 387,000 crystals per cc. in the other. The massecuites in both instances were quite normal and cured perfectly satisfactorily, although in one case nearly three times as many crystals were present as in the other. In this connection, it is interesting to note the figures given by Thieme ([4]) for the number of crystals present in two final low purity strikes. These figures when calculated to the number of crystals in 1cc. of the massecuite at striking point, correspond to 57,400 and 110,250. The conclusion to be deduced from these figures would appear to be that the estimate of the

practical pan boiler is an approximate one and a variation of 100 to 200 per cent. in the number of crystals formed in two consecutive strikes would be a normal variation.

Thieme has pointed out that when large numbers of crystals are present in a massecuite, big differences in the number of crystals have very little influence on the size of the grain. For instance, in the examples cited, Thieme has calculated that with 57,000 crystals per cc. the average crystal in the final massecuite would measure 0.30 mm. whilst with 110,000 crystals per cc. the average crystal would measure 0.26 mm.

It should be noted that the practice adopted at Carrington Factory is to make an even greater number of crystals than is apparently the Java practice. In order that the final massecuite shall not be too fine grained, these crystals are made larger by boiling with syrup as already described. For low purity strikes this method appears a very good one in that the larger number of crystals formed yields a greater surface area for sucrose deposition and this is very necessary in the viscous supersaturated low purity mother liquor. At the same time, the crystals are made sufficiently large by the preliminary boiling with high purity syrup to ensure that curing will not be hindered at the centrifugals.

Two methods which have been described in the literature for determining the number of crystals in a graining syrup have been mentioned, *viz.*: the counting method and the visual method assisted by standard tablets. The counting method can scarcely be regarded as a practical method for obtaining correct numbers of crystals for low purity strikes. The method is tedious and owing to the time necessarily taken up in counting, the method cannot yield accurate results. The visual method of estimating numbers of crystals by comparison with standard tablets is also open to objections. It is necessary that the graining syrup should always be viewed through a uniform thickness—Thieme suggests 0.5 mm.—but this is difficult to obtain in practice where the viscosity of the graining syrup is rapidly altering. The comparison of the standard tablet with the sample will also depend for its accuracy on the observer's capacity of interpreting the sample in terms of the tablet. The method would seem to need considerable practical experience on the part of the observer in order to achieve approximately accurate results.

A third method of obtaining the requisite numbers of crystals for any particular strike is suggested by the work which has been carried out on graining with the aid of the refractometer. The refractometer enables a continuous control to be exercised over the supersaturations of the syrup in the pan and it would seem that if a certain supersaturation were suddenly introduced into a syrup, the number of crystals formed would be proportional to the degree of supersaturation.

Kucharenko ([5]) has shown that the velocity of crystallization increases rapidly with the supersaturation of a sucrose solution. In these investigations it has also been found that the number of crystals forming at a supersaturation of 1.5 are much less than the number forming at a supersaturation of 1.6. It is highly probable that the purity of the syrup and other factors will influence the effect of supersaturation on crystal numbers, but if these factors could be worked out and allowed for a method of defining the required number of crystals in terms of the supersaturation of the syrup would seem to have possibilities even in the hands of a novice.

It was only possible to carry out one experiment on this method, but if possible, this matter will be further investigated during next crop season. In the experiment undertaken the supersaturation of the syrup was suddenly raised from 1.3 to 1.6 and the number of crystals which resulted were counted. It was found that 249,000 crystals were present in 1 cc. when calculated on the same basis as previously described. It will be seen that this number compares very favourably with the number formed by the "waiting" process when a similar supersaturation was obtained.

Summary.

The investigation of the control of pan boiling with the aid of the Zeiss Industrial Refractometer has been continued and the results previously obtained have been confirmed. As the outcome of this year's work, suggestions are made for the more efficient boiling of final low purity strikes.

The process of grain formation has been investigated and the supersaturations of graining cane syrups have been determined.

It has been shown that the "vacuum" method of graining which yields a uniform grain can be as readily controlled with the aid of the refractometer as the "waiting" method.

Acknowledgments.

The author desires to thank the management of Carrington Factory without whose co-operation this work could not have been undertaken. He especially wishes to record his appreciation of the assistance rendered him from the engineering side by Mr. Greenidge, the manager and from the chemical side by Mr. F. Hutchins, the chemist of Carrington Factory.

References.

(1) Saint, S. J. *Tropical Agriculture*, 1928, 5, pp. 279-283.

(2) Jackson and Gillie.—Scientific Paper No. 375. *Bureau of Standards, Method* 4.

(3) Baldwin, W. A. *International Sugar Journal* 1918, Vol. XX, p. 243.

(4) Thieme, J. G.—"Studies in Sugar Boiling" p. 49 and p. 51.

(5) Kucharenko, J. A.—"The Crystallisation of Sucrose" *The Planter and Sugar Manufacturer*, 1928.

TRINIDAD AND JAVA CACAO.

Selection Research Work on Cacao in Trinidad and in Java.

By C. J. J. Van Hall.

In his interesting paper "Results of Cacao Research at River Estate" (*Tropical Agriculture*, Vol. VI, p. 127) Mr. Freeman gave a brief summary of the cacao research work done on the Trinidad Government Experiment Station. Of that work, the selection, about which Dr. Harland gave some details in a paper read before the Agricultural Society of Trinidad some time ago, may be regarded as the most important part.

As Mr. Freeman explained, the selection work was begun after recognition of the fact that the manure applied was a very minor factor in determining the yield of a tree, and that a shy bearer remains a shy bearer even when it is manured heavily during a period of several years.

It is well known, especially when Mr. de Verteuil's figures are considered, that most of the cacao trees are very poor bearers. In fact the plantation fields contain anything from 30 to 50 per cent. of trees not yielding more than 1 lb. of cacao each per annum, and another 20 per cent. giving below 2 lb. each. This is not to be wondered at, when we remember that the mixture of races or varieties planted in our cacao fields is the same as is growing wild in the virgin forest, no selection having been done since the time when the first cacao seeds were brought from the forest and sown out.

When we realize how great is the difference between the cereals or fruit trees which are planted in our fields and orchards and their wild ancestors, it is obvious how far behind we are in planting our cacao fields with the mixture of types—many poor ones and a few superior ones—that is present in the virgin woods. There is no reason to think, however, that we should not be able to attain by selection results with cacao as striking as those which have been obtained by selection of cereals or fruit trees in Europe and America, and we may therefore look with interest at the selection work done in Trinidad and in Java.

Our selection work on cacao in Java seems to have remained unnoticed in the West Indies and this makes it for me an agreeable task to give the readers of *Tropical Agriculture* some information about this work.

A few words may be said about the variety cultivated in Java.

During many years the pure Criollo was the only variety cultivated and the well known "Java-cacao" of 25 years ago was nothing but a pure Criollo-produce.

Though the quality was first rate, it was still behind the Venezuelan Criollo, known in commerce as "Caracas cacao," and this was a motive for one of the prominent cacao planters in Java, Mr. H. MacGillavry, manager of the Estate "Djati Roenggo," to have some cacao plants ordered from Venezuela. What he got in a Wardian case, however, were not plants of the variety which gave the famous "Caracas cacao," viz.: Criollo-plants, but plants of an inferior Forastero-type as appeared a few years later, when the tree began to bear fruit. The pods were small and the seeds flat and dark-violet in colour. Nevertheless the seeds were sown out. But when these daughter-trees bore fruit, it appeared that the pods had qualities intermediate between the mother tree from Venezuela with its flat, dark coloured seeds, and the old "Java cacao" (the Criollo) with its white round seeds. Mr. MacGillavry at once realised that hybridisation had taken place, and he gave the offspring of the Venezuelan mother tree the name "Djati Roenggo hybrid."

The "Djati Roenggo hybrid" became the favourite and popular variety in Java. When the old Criollo went backward and the old fields had to be replanted, replanting with Criollo was a complete failure; the young trees had a very poor growth. The hybrid, however, did very well in the old fields, especially when a green manuring plant—by preference *Leucaena glauca* or *Tephrosia candida*—was interplanted, and at present most of the cacao fields are planted with this variety. The "Djati-Roenggo hybrid" is very variable and it shows a great number of different forms of fruit and seed, all being types intermediate between the true Criollo and the typical Amelonado Forastero. The quality of its marketable produce is quite good, and only slightly inferior to the old Criollo cacao. A drawback, however, is that its yield is not high, and certainly lower than that of the old Criollo.

Selection work was started in 1912 on the estates "Djati Roenggo" and "Getas," by selecting a number of trees of the "Djati Roenggo hybrid" variety supposed to be high bearers, while on the plantation "Assinan" a number of imported trees of a variety known as "Assinan Angoleta" were selected. Only on the plantation "Djati Roenggo" was the work continued. Here it was carried on with much care and energy by the manager of the plantation, Mr. E. E. L. MacGillavry, and his first assistant, Mr. Wiersma (now manager of "Assinan" Estate). It is with pleasure that I recall the agreeable work done with these two collaborators during the period from 1912 to 1926.

In order to obtain self-fertilized seed, the selected trees of the first set (Nos. 1, 2, 3, 7, 10, 11, 12, 17, 18, 20, 21, and 24) were isolated by means of mosquito netting. This method, however, had the drawback that very few pods were obtained. Apparently the enclosing of the tree, which kept off the wind, impeded the pollination. This made us abandon the netting, and a free pollination was allowed, a measure which certainly had the disadvantage that the

seedlings obtained were the offspring of an unknown father, but was necessary as we did not see our way to getting sufficient seeds by self-pollination.

A few years later 12 new "mother trees" were selected. Our 24 mother trees were used for budwood, and a plot of budded offspring was made from each. Plots have also been made with seedlings from each tree, but only 12 of these are at present in production.

The soil where the "budded daughter" and "seedling daughter" plots were planted was poor, and the yield was low, but nevertheless they serve to indicate the *relative* bearing power of the different strains.

The yield of the budded offspring and the seedling offspring of the different mother trees was recorded for all the plots in the years 1923, 1924 and 1925, after which only the yield of the budded strains was recorded. The figures for 1925 are very low in consequence of a destructive drought which lasted for several months, and which caused not only a great depression in the yield of the trees, but also the death of many. The figures for 1925, therefore, cannot be used alone as an indication of the productivity of the different plots.

I shall omit giving here all the figures of the yield of the different plots, and mention only the most important conclusions which we drew from the figures for 1923 and 1924. These conclusions are:—

1. The average yield of the budded strains and of the seedling plots was lower than that of the mother trees.
2. The deviations from the average yield were smaller in the strains than in the mother trees.
3. The deviations from the average yield were in the seedlings smaller again than in the strains.
4. There is a correlation between the yield of the mother trees, the yield of the corresponding strains, and the yield of the corresponding seedling plots.

Conclusions 1, 2 and 3 may be illustrated by the following table:—

	Number of pods per tree.		
	Poorest bearer.	*Average.*	*Heaviest bearer.*
Mother trees ..	30	108	462
Budded strains ..	2	20	61
Seedling plots ..	22	27	36

As regards conclusion 4, our figures show that *as a rule* a heavy-bearing mother tree produces heavy-bearing offspring. It is also a fact—as was also pointed out by Dr. Harland for the descendants of the mother trees in Trinidad—that this is *not always* the case. The property of a tree of being a heavy bearer may or may not be hereditary, but the former is the rule. This is apparent from the following graphs, on which are indicated the yields of our mother trees and their budded offspring.

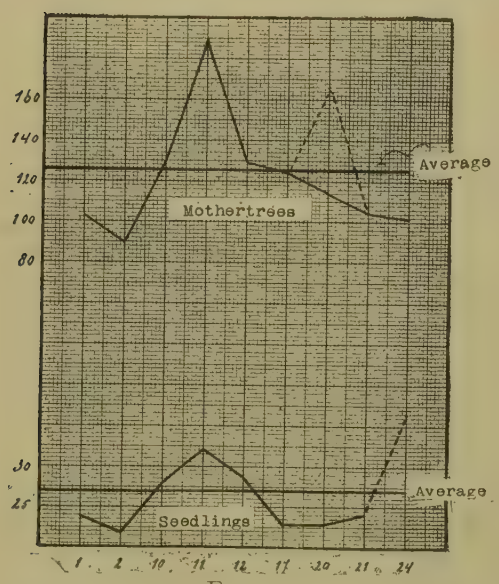


FIG. 1.
Yield (in pods) of nine seedling plots and mother trees in 1923 and 1924. Correlation is shown in all cases except two (dotted).

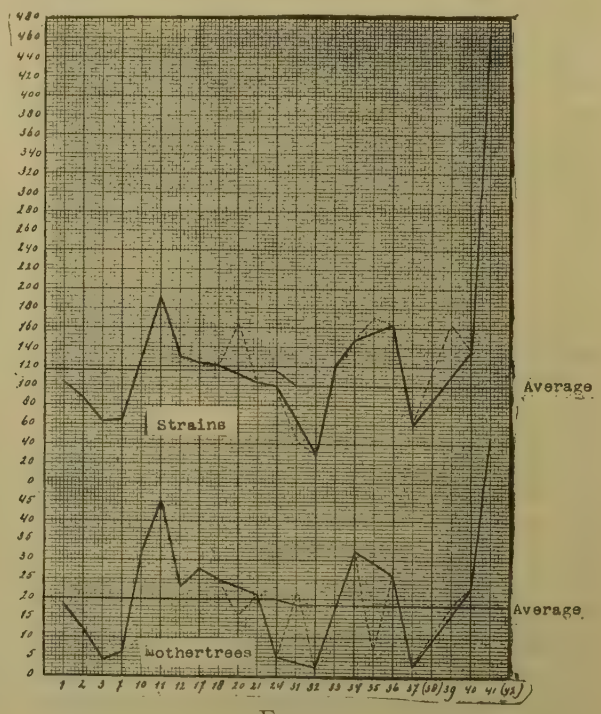


FIG. 2.
Yield (in pods) of strains and mother trees in 1923 and 1924. Correlation shown in all cases except four (dotted). Nos. 38 and 42 not plotted.

The practical conclusion from this observation is, that there is a fairly good chance that a heavy bearing tree will have a heavy bearing offspring, and that a planter who has no opportunity to do the selection along scientific lines by recording the yield of the offspring of each selected tree separately, will still obtain some satisfactory result in using seeds or buds from his best yielding trees instead of using seeds gathered at random. But it is true that in this way he will obtain only a majority of trees belonging to superior races or varieties or strains—the name is immaterial—and a minority belonging to shy bearing strains.

Up till 1926 we in Java satisfied ourselves, in the same way as has been done in Trinidad, by recording only the number of pods of each plot. It was the merit of our successors, Dr. C. P. Cohen Stuart and Mr. J. Th. de Haan, to realize that the number of pods is a very incomplete indicator of the productiveness of a tree or a strain. A strain may have a small type of fruit, which gives a small amount of cacao, while another has a large fruit, which gives a large amount of cacao.

In order to find what the average production is of one fruit of each strain, a number of fruits of each strain was separately fermented and cured and the cacao thus obtained, was weighed. In this way the average yield in cacao of one fruit of each strain could be figured out.

Though it had been expected that there would be an appreciable difference in this respect between the different strains, the differences were still larger than had been anticipated. The average yield of one fruit was found to vary in the different strains between 16.7 grammes of cacao and 50.0 grammes, so that in one strain 59 fruits are needed to give 1 kg. of cured cacao and in another strain only 20 fruits. This fact caused an alteration in our appreciation of the different strains.

The following list may give an idea of the yield in pods and in cured cacao of the different strains (budded offspring in 1927). The strains are arranged in this list according to the yield in cacao.

Production of the different strains in 1927.

No. of the strain.	Average number of pods per tree.	Average yield in cacao.			
		per pod.	per tree.	per acre (160 trees.)	per hectare (400 trees.)
		gm.	gm.	kg.	kg.
11	77.4	45.8	3,550	568	1,420
36	100.7	30.8	3,120	499	1,248
2	55.4	45.0	2,500	400	1,000
1	46.9	50.0	2,340	374	936
38	47.1	46.5	2,190	350	876
41	53.8	40.0	2,150	344	860
12	47.5	45.0	2,140	340	856
10	59.5	32.5	1,940	310	776

Production of the different strains in 1927.—*Contd.*

No. of the strain.	Average number of pods per tree.	Average yield in cacao.			
		per pod.	per tree.	per acre (160 trees.)	per hectare (400 trees.)
		gm.	gm.	kg.	kg.
39	31.3	38.3	1,230	197	492
17	43.3	27.5	1,190	190	476
18	33.8	34.3	1,160	186	464
42	31.0	36.5	1,130	181	452
34	29.0	34.2	990	158	396
31	25.0	37.5	940	150	376
40	28.7	32.5	930	149	372
24	26.2	33.8	890	142	356
35	21.8	30.2	660	106	264
21	15.6	41.7	650	104	260
33	20.7	25.0	518	83	210
20	9.1	31.0	290	40	116
37	10.0	16.7	170	27	68
7	5.3	27.8	150	24	60
3	4.6	20.0	90	14	36
Over-all average.	39.4	34.9	1,370	219	548

These figures give the yield of the year 1927, which was a very good cacao year, as is apparent when we consider that in this year the average number of pods per tree was 34.9, while in 1923 and 1924 the number was 25.3 and 23.4 (1925 was a year of exceptional drought with a very low yield, while in 1926 the trees were still feeling the consequences of this drought and had a poor yield). Probably a number of 25 pods per tree may be considered as a general average of our experimental field (this would amount to 876 gm. per tree or 140 kg.=310 lb. per acre).

The list of the production of the different strains in 1927 shows that in this year strain No. 11 gave the highest yield in cacao, much higher than the next one (No. 36), though the number of pods of the last mentioned number (100.7 pods) is much higher than that of No. 11 (77.4 pods per tree).

We need more data about the production of the different strains in order to get a reliable impression of their productivity. It is especially needed to have the strains planted in experimental plots on different soils so as to be able to compare the yield with that of ordinary seedlings. But it is certainly already apparent, that more than one of our strains is of much higher productivity than the average. This has been the case in the three years of close observation (1923, 1924 and 1927) with the strains 11, 36, 1, 41, 12 and 10.

Characters other than the productivity which are equally worthy to be studied in the different clones are: the susceptibility to important pests and diseases and the quality of the product.

The susceptibility to the cacao-moth (*Acrocercops cramerella*) is very different in the different strains. The proportion of pods damaged by this insect appeared to vary between 57 per cent. and 100 per cent. For the damage done by the

Helopeltis bug it is not so easy to find a reliable standard, which enables us to express numerically the susceptibility of each strain, but it is clear that the different strains show differences in this respect also and it is of importance to have these well recorded.

As regards the quality, samples of 19 clones were examined by a broker in Amsterdam, but this expert did not find great differences in quality.

To the readers of *Tropical Agriculture* it will be superfluous to describe the selection work done in Trinidad. The paper of Mr. Freeman cited contained the main points. But it may be interesting to reproduce here a few of the figures given by Dr. Harland in his paper, read before the Agricultural Society of Trinidad.

In the selection experiments at "River Estate" the offspring of 28 selected heavy bearing trees were planted out in plots; of each mother tree 40 budded and grafted descendants and 20 seedlings were planted

The following list gives the figures of the yield of the two best strains (budded and grafted descendants), viz.: Nos. 1,480 and 2,190, and of the average of the 28 strains during the last two years, and also of the two best seedling plots (descendants of the trees 407 and 969) and of the average yield of the seedling plots.

Production per year in the last two years.

No. of the strain or seedling-plot.	Number of pods per tree	Calculated Yield in Cacao.		
		per tree in gm.	per acre (of 280 trees) in kilogm.	per hectare (of 700 trees) in kilogm.
Strain 1,480	45	1,845	517	1,290
Strain 2,190	44	1,800	504	1,260
Average of Strains ..	23	945	265	662
Seedlings 407 ..	42	1,717	481	1,202
Seedlings 969 ..	41	1,680	470	1,175
Average of seedlings ..	24	982	275	687

The figures for the yield of marketable cacao per tree, per acre and per hectare have been deduced from the figures given by Harland about the bags of marketable cacao per 1,000 trees (one bag = 165 lb. or 75 kg.). If we compare the figures of the number of pods per tree and the number of bags per 1,000 trees, it appears that the number of bags has been figured out for all the strains by assuming that 41 fruits are needed to give 1 kg. of marketable cacao. It must be borne in mind that this premise may be a source of error. As we noted above, the investigations of Cohen Stuart and de Haan proved that the yield of marketable cacao obtained from 1 pod was very different in the different strains, the lowest yield being 16.7 gm. (strain No. 37 of Cohen Stuart and de Haan), and the highest yield 50.0 gm. (strain No. 1). It would therefore be advisable that for the Trinidad strains also the yield of cacao per pod should be figured out by fermenting and drying separately a certain number of pods of each strain.

It is to be regretted that not all the figures of the yield of the different strains and seedling plots have been published. Without doubt interesting conclusions could have been drawn from these figures.

The best producing strains produced in 1927 in Java about the same yield as the best strains in Trinidad (per acre in Java 586 and 499 kg., in Trinidad 517 and 504 kg.), but this is pure coincidence, and we must not forget that the year 1927 was in Java an exceptionally good cacao year. Most probably our best Java strains will be less productive than the Trinidad strains, either because in Java the soil is not so suitable for cacao as in Trinidad, or because our strains are not such heavy bearing ones.

It would certainly be of much interest if the scientific men in Java and in Trinidad, who are both working on cacao selection, but up till now independently of each other, would come into closer contact.

The interchange of planting material would allow a comparison of the value of each other's strains and seedlings under the conditions of Java and Trinidad, and it is not impossible, that this would lead to interesting conclusions. Besides, the interchange of opinions and experience would doubtless be instructive.

COCOA MOULDING.

Mr. T. Laycock, the Senior Mycologist, Nigeria, reports that experiments are being carried out with the object of determining the causes of moulding of cocoa beans. These indicate that fermented cocoa moulds much more rapidly than does unfermented cocoa. The experiments also show that fermented beans reabsorb moisture much more rapidly than do unfermented and the degree of moulding is correlated to the amount of moisture present within the beans. The difference in pH value of the two samples also affects the degree of mouldiness. The unfermented beans are much more acid than are the fermented ones (the pH being 3.4 and 4.8 respectively), and this greater acidity appears to inhibit moulding. Experiments with culture media obtained from extracts of fermented and unfermented beans indicate that the different degree of moulding is not solely due to the degree of acidity of the two media, but that the chemical nature of the fermented beans is such that it forms a more suitable pabulum for the development of fungi.—(*Bulletin of the Imperial Institute*, Vol. XXVI, No. 2, 1928.)

CITRUS PRODUCTS INDUSTRY.

[*Reprinted below are extracts of an article on "The Citrus Products Industry" which appeared in the October issue of the Bulletin of the Imperial Institute and which was based on a memorandum recently supplied to the Empire Marketing Board by the Imperial Institute.*]

THE most important citrus products from a commercial standpoint are the following:—

1. *Citrate of Lime* and its derivative *Citric Acid.*
2. *Concentrated Juice.*
3. *Raw Juice.*
4. *Essential Oils.*

The principal fruit concerned is the lemon, but the lime is also a valuable source of the products, while increasing quantities of oranges are also being utilised, especially in the United States. It may be mentioned that pineapple juice and pineapple waste, which are obtained in large quantities from the canning factories, are now used in the United States as an important source of citrate and citric acid.

1. Citrate of Lime and Citric Acid.

Although citric acid is present, together with small amounts of other organic acids, in the juice of citric fruits, it is not feasible to extract the acid direct from the juice. The citric acid is always first separated by means of its sparingly soluble calcium salt. For this purpose the hot juice, after suitable preliminary treatment, is neutralised by the addition of whiting or ground chalk, or ground limestone if sufficiently pure; the citrate of lime, which is precipitated, is filtered off, washed and dried. The citrate may be prepared either from freshly extracted juice or from the concentrated juice. The whiting or chalk used for the purpose must not contain more than traces of iron, alumina, magnesia and phosphates.

Citric acid is prepared from the citrate of lime by treatment with sulphuric acid and is purified by recrystallisation.

A very pure grade of citric acid can be obtained by the fermentation of sugar with certain moulds, and within the last few years this process has been established on a commercial scale both in Europe and America.

Italian and American Production.

Statistics of the total imports of citrate of lime and of citric acid into the United Kingdom, show that Italy is by far the most important source of both products. The industry in that country is highly organised and it should be noted that the lemons used for the preparation of the essential oil and citrate of lime are the surplus fruit remaining over after the needs of the important export trade in fresh lemons have been satisfied. Unusually favourable conditions in the fruit industry may therefore result in restriction of the supplies of lemons available for the citrate and citric acid industries. On the other hand if there is a reduced demand for fresh fruit the surplus is used for the production of oil and citrate, the latter of which is at once consigned to an organisation at Messina (the Camera Agrumaria) at a price fixed in advance. The average production of citrate in Sicily is stated to be 7,000 to 8,000 tons per annum, and some time ago large stocks had accumulated at Messina. These, however, have been substantially reduced during recent years and last year amounted to about 10,000 tons.

As the great bulk of the world's supply of citrate has been produced in Sicily, the Camera Agrumaria has been able to control the market and to fix the selling price. Latterly as a result of this control the manufacture of citric acid in Italy has been largely developed and less citrate has been available for manufacturers in other countries. By arrangement with the Italian producers the manufacture of citric acid in Germany was abandoned several years ago and Germany now imports the acid instead of the citrate from Italy.

A recent development in the Italian industry is the formation of "Cifac" (Consorzio Italiano Fabbriche Acido Citrico), a syndicate of all the Italian citric acid manufacturers with offices in Messina, the object of which is to control the supply, distribution and price of the citric acid made by the firms concerned. It is understood that the firms comprising the syndicate will have first call on the citrate made in Sicily and that only such quantities will be exported as the firms cannot immediately handle. The effect of this arrangement will be felt most in countries, such as the United Kingdom, which are dependent wholly or mainly on imported supplies of citrate and citric acid. It should stimulate, however, the production of citrate in other countries and manufacturers in the United Kingdom have informed the Imperial Institute that they will welcome supplies from new sources. The situation may also have an influence on the development of the manufacture of citric acid from sugar by fermentation processes.

The United States (California) is a producer of citrate of lime, the surplus lemon and orange crop being employed in its manufacture as well as pineapple juice and waste. Concentrated lime juice is also imported from the West Indies, and citrate of lime from Italy for the manufacture of citric acid. The fermentation process is now being employed on a commercial scale in the Eastern States.

Empire Production.

The production of citrate of lime in the British West Indies has practically ceased, imports into the United Kingdom having fallen from 40,320 lb. in 1924 to 3,360 lb. in 1925 and 3,584 lb. in 1926, while no figures are shown for 1927. Exports now consist of raw or concentrated lime juice.

Citrate of lime was formerly made in British Guiana from lime juice, but the manufacture failed to give remunerative results and ceased in 1921.

The production of citrate of lime was undertaken in East Africa in 1921, but was soon discontinued and no developments have since taken place. Judging, however, from enquiries received recently at the Imperial Institute from both Kenya and Tanganyika, interest is again being taken in the product in those countries.

Small quantities of citrate of lime have been produced recently in Cyprus from locally grown lemons and consignments which reached this country were of satisfactory quality.

Present State of the Market.

To sum up it may be stated that there is a good demand for citrate of lime in the United Kingdom at the present time owing to the limitation of exports from Italy. British manufacturers of citric acid have stated that they would welcome additional supplies from Empire sources and these, if of good quality, would meet with a ready sale.

As regards the future demand, the possibility of an increased production of citric acid by fermentation methods has to be taken into account, but at present it is not possible to estimate the extent to which this new process will be utilised commercially.

The standard strength of commercial citrate of lime is 64 per cent. of citric acid. The price in London has recently been about £22 per "pipe" of 6 cwt. (on basis of 64 per cent. citric acid content).

2. Concentrated Juice.

The chief citrus fruits used in the preparation of concentrated juice are lemons (in Italy) and limes (in the West Indies). The raw juice as expressed from the fruits is usually concentrated by evaporation either in open pans or preferably in steam-heated stills until it contains about 100 oz. of citric acid per gallon.

In making concentrated lime juice in a steam-heated still, the oil which distills over is collected and marketed as "distilled oil of lime." The value of this oil is an important item in the financial returns obtained from the process.

Concentrated juice forms a convenient medium for the transport of citric acid in those cases where, owing to the absence of suitable whiting or chalk, or through other causes, it is impracticable to make citrate of lime. The juice is used not only as a source of citrate of lime and ultimately of citric acid, but is also employed directly for certain industrial purposes.

The trade returns of the United Kingdom do not differentiate between concentrated and raw juice, or between lemon and lime juice. The total imports of such juices into this country have been as follows :—

	1924.	1925.	1926.	1927.
	Galls.	Galls.	Galls.	Galls.
Total ..	424,810	497,982	540,625	467,109
From British West Indies ..	281,527	368,608	264,260	184,092
Italy ..	88,586	101,600	256,534	266,930

Speaking generally, it may be said that juice from the British West Indies consists of both concentrated and raw lime juice, while that from Italy is mainly raw lemon juice.

Production in British Empire.

The exports of concentrated lime juice from the British West Indies have fallen much below the figures of former years, owing to the damage caused by root diseases and withertip disease in Dominica which has resulted in a greatly reduced yield of fruit in that island. (*See* Table I.)

Other British countries which are producing concentrated juice on a small scale are the Union of South Africa and Cyprus. In both cases lemons are used as a source of juice.

Concentrated lime juice was prepared in East Africa in 1921, but the manufacture was not continued on a commercial scale.

Present State of the Market.

In view of the established market in this country for concentrated lime juice, its production could be safely undertaken as an alternative to the preparation of citrate of lime. It is important, as indicated above, that the essential oil expressed with the juice should be recovered during the process of evaporation as its value adds considerably to the financial return obtained.

The juice is concentrated until it contains about 100 oz. of citric acid per gallon and is exported in casks containing 40 to 50 gallons. The present price in London is £28 per pipe of 108 gallons containing 64 oz. of citric acid per gallon. The price of concentrated juice containing larger amounts of citric acid per gallon is proportionally higher.

3. Raw Juice.

Raw citrus juice, prepared from limes, lemons and oranges, is used for making beverages. As explained in the preceding section on concentrated juice, it is not possible to give the imports of raw citrus juices into the United Kingdom.

The production of raw lime juice in the West Indies, as in the case of the concentrated juice, has been greatly affected by the diseases. (*See* Table I.)

The demand for raw lime juice is seasonal and largely influenced by the character of the summer weather. The state of the market is an important factor in deciding whether raw juice can be profitably shipped and it is therefore necessary for producers to keep in close touch with importers in this country. The present price of raw lime juice in London is about 4*s*. 6*d*. per gallon.

During the last 3 or 4 years there has been a very large increase in the export from Italy of raw lemon juices which is being increasingly utilised for the production of beverages.

4. Essential Oils.

The chief essential oils produced from citrus fruits are the following: Lemon oil, Lime oil, Orange oil, Bergamot oil and Mandarin oil. The oils are obtained from the peel by pressure and in the case of limes and oranges also by distillation.

In making the expressed oils, the oil cells in the peel are ruptured by pressure or by rotating the whole fruit in an écuelle and the oil which exudes is collected. The finest lemon oil is obtained in Sicily by pressing the peel in contact with a sponge, which absorbs the oil. Recently pressing machines have been introduced in Sicily for the purpose. Expressed lime oil is chiefly made in the West Indies by the process of écuelling.*

In the case of limes and oranges the fruit after being écuelled is submitted to pressure whereby the juice is expelled together with a further quantity of oil.

Distilled lime and orange oils are obtained as by-products in the manufacture of the concentrated juice. Citrus oils prepared by distillation are of lower quality and value than expressed oils, owing to changes brought about during the process of distillation.

Exports of citrus oils from the West Indies and Italy are shown in Tables I and II. Other important exporting countries are Spain and France. Hitherto, these countries have not published figures showing the export of citrus oils, except that in 1928 the total export of all citrus oils from France is given as the equivalent of 74,005 lb.

Present State of the Market.

The principal source of supply of lemon oil is Italy, although increasing quantities are now being produced in California. The latter oil is chiefly marketed in the United States. There is always a good demand for lemon oil and during 1928 the price in London rose steadily from 8*s*. per lb. in January to 12*s*. 6*d*. in July and to 14*s*. to 15*s*. at the end of the year. The present price is 15*s*. 6*d*. to 16*s*. per lb. in London.

The rise in price is attributed in the market to a reduction in the Italian production. The Imperial Institute has recently been informed that owing to the large demand for fresh lemons last season much of the fruit which would have been used in Italy for the manufacture of oil and citrate was exported and that consequently the amount of oil produced was very low.

Lime oil has been realising high prices owing to a good demand and shortage of supplies from the West Indies due to diseases and the effect of the recent hurricane. Up to 34*s*. per lb. has been paid recently in London for the distilled oil, and the range in price during 1928 was 24*s*. to 30*s*. per lb. The London price of the hand-pressed oil ranged from 35*s*. to 40*s*. per lb. during 1928; this oil is at present scarce and worth nominally 65*s*. per lb.

* An écuelle is a saucer-shaped vessel made of tinned copper, the inside of which is covered by short spikes, about ½ inch long. The fruit is placed in the écuelle and by a rapid rotatory motion the oil cells are ruptured and the oil so released is collected through a tube leading from the bottom of the écuelle.

TABLE I.—WEST INDIES CITRUS PRODUCTS.

EXPORTS.

Year.	I Concentrated Citrus Juice.	II Raw Citrus Juice.	III Lime Oil.	IV Orange Oil.
	Gallons.*	Gallons.	Lb.	Lb.
1924	349,779	435,531	65,581	85,854
1925	264,357	431,365	63,430	105,797
1926	182,077	388,196	65,924	64,805
1927	176,097	252,608	64,682	90,638

I.—CONCENTRATED CITRUS JUICE.

Represents total exports from Dominica, Jamaica, St. Lucia, Antigua, Grenada, Trinidad and Tobago, and British Guiana. Jamaica's figures include raw juice. Very nearly $\frac{5}{6}$ of the concentrated citrus juice exports find their way on the U.S.A. markets. Note fall in exports.

II.—RAW CITRUS JUICE.

As in (I) but excludes Grenada, Trinidad and Tobago and includes St. Vincent and Montserrat. Jamaica's figures include concentrated juice. The large proportion of exports of raw citrus juice is directed to the United Kingdom; U.S.A. and British North America being the next importers. Note fall in exports.

III.—LIME OIL.

As in (I) but excludes Jamaica and includes Montserrat. These exports include écuelled, distilled and hand-pressed oil. The two chief importing countries are U.S.A. and the U.K. with small quantities going to Canada.

IV.—ORANGE OIL.

Only includes Jamaica and Dominica.

* Gallon = 8.65 lb.

TABLE II.—CITRUS PRODUCTS EXPORTS FROM ITALY.

Year.	I Concentrated Citrus Juice (1).	II Raw Citrus Juice.	III Lime Oil.	IV Orange Oil.
	Lb.	Lb.	Lb.	Lb.
1924	1,537,063	1,140,672	1,653,579	279,548
1925	2,329,624	1,718,283	1,712,299	263,049
1926	2,270,541	4,239,048	1,371,405	278,228
1927	1,287,058	5,466,581	1,259,756	303,568

(1) Italy and Martinique. Italy also exports large quantities of bergamot and mandarin oils.

COTTON NOTES.

By S. C. Harland, D.Sc. (Lond.),
Chief Geneticist, Trinidad Cotton Research Station.

Recent work on the Genetics of Cotton.

Most genetic studies in cotton have been made on hybrids between Upland (*G. hirsutum*) and Egyptian or Sea Island (*G. barbadense*). Such crosses have been usually made with the object of combining the desirable characters of both species. Thus a combination of the long silky lint of Egyptian with the large boll and early maturity of Upland would be economically very valuable. But no matter how many plants are grown in F_2, the expected combination does not occur, although the F_1 type is just what is wanted. It is clear that the problem of combining the desirable characters of *species*, offers far greater difficulties than similar work with varieties. Recent genetic studies are beginning to throw a flood of light on the mechanism of inter-specific crosses. The present writer (*Memoirs of the Cotton Research Station, Trinidad No. 1, Ser. A*) has studied the inheritance of three simple, or apparently simple characters in inter-specific and also in intra-specific crosses. These are (1) petal spot, (2) flower colour, and (3) pollen colour. Unexpectedly complex results were encountered, but the results of varietal crosses helped to explain those of the more intractable inter-specific crosses. The first point of importance is that while inheritance in the varietal crosses was simple, with clear segregation in mono-hybrid fashion, that in the species crosses was invariably of the blending type. A typical example may be given.

Petal Spot—The plants were classified into 25 different grades of spot, each plant being examined five times and the mean taken. The lowest grade of spot above spotless consisted of perhaps two or three pigmented cells.

Spot Grade.

	0	.25	.50	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	14	19	5	23	27	35	22	7	6	5	10	8	1	5	—	8	24	52	68	144	111	73	29	8	—
2	117	14	11	12	6	11	5	6	5	15	16	19	39	56	37	21	24	22	33	8	5	—	—	—	—

1. Segregation of spot in a varietal cross strong × weak (Inter-Peruvian).
2. Segregation of spot in an inter-specific cross spotless × full spot (Upland-Peruvian).

The point to notice is that while there is a definite break in (1) at 12 and that full spot and weak spot are allelomorphic characters, there is in (2) no definite break at the point between spotless and spotted. What in fact are we to call spotless? It is true that between four and seven there are relatively few plants, but we are not helped much further forward by dividing the frequency array at this point. There is in fact no definite line of demarcation between a spot factor and its allelomorph, and inheritance is blending. If, however, the F_1 of such a cross is back-crossed to the full spot parent and the plants selfed, we meet with considerable simplification in some cultures. One of these is placed below.

Spot Grade.

Family ..	0	.25	.50	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
432 ..	1	1	2	4	1	2	—	—	—	—	—	1	2	2	6	4	3	3	1	5	3	—	—
	Weak spot. 11											*Strong spot.* 30											

Here we have simple segregation into strong spot and weak spot in the 3 : 1 ratio, and the pair of allelomorphs is distinctly seen. The explanation put forward to account for these results is as follows:—

In the inter-specific cross there is segregation of a factor pair, full spot—weak spot. In addition there is also segregation of an unknown number of modifiers, which affect spot in a plus or minus direction. If plus modifiers are added to Upland spotless a faint spot up to grade four will be produced, as in the above family. Back crossing of the F_1 to the full spot parent will make some plants pure for a number of plus modifiers, which will raise 0 to 4, and also raise intermediate grades to

full. It is the raising of the intermediate grades to full which causes the gap between full and weak.

The situation in regard to pollen colour is very similar. Contrasting the results of the varietal cross with the inter-specific we have:—

VARIETAL.

Inter-Peruvian.—Golden yellow by cream gave in F_2, three golden yellow: one cream.

INTER-SPECIFIC.

Upland and Peruvian.—Golden yellow by cream gave in F_2, three yellows ranging from golden to pale: one cream ranging from dark to pale.

In both types of cross there is a single allelomorphic pair, yellow-cream, but whereas in the first type there is no segregation of modifiers, there is in the second type an almost continuous gradation from deep yellow to pale cream making it very difficult in some crosses to distinguish between the yellow section and the cream. By back crossing the F_1 with golden yellow and selfing, we get some plants which segregate directly into golden yellow and cream with no intermediate shades and no blending. Further, if we take a cream which is a segregate from a family which shews clear segregation into golden yellow and cream, we can use it to clear out intermediate grades in a cross which shews blending. For, *ex hypothesi* it contains a full complement of plus modifiers, and in the back cross will raise the cream series little, but the yellow series much. Thus the gap between the yellows and creams will be widened.

To sum up; pollen colour, spot and corolla colour are determined by a simple factor pair in both varietal and inter-specific crosses. In varietal crosses there is segregation of the main gene alone, whereas in the inter-specific cross there is segregation of modifiers which may partially, or in some cases entirely, obscure the distinction between dominant and recessive.

There is thus no real difference in the mechanism of inheritance in inter-specific, from that which exists in varietal crosses. These "blocks" of modifiers, do, however, introduce an enormous complication into the problem of combining the desirable characters of two species. Indeed the problem of breeding for desirable combinations of economic characters resolves itself almost entirely into the manipulation of modifying factors. Suppose for example our object is to combine upland corolla colour with the petal spot and pollen colour of Sea Island. The situation may be something like this:—

UPLAND *y* [*a b c*]	PERUVIAN Y [A B C]
s [*d e f*]	S [D E F]
p [*g h i*]	P [G H I]

The letters in brackets signify modifying factors necessary to produce the character. Thus S with D, E and F, may be regarded as full spot. But the lack of D, E or F, or any combination of them diminishes the intensity of the spot. Similarly the full yellow pollen colour of Peruvian requires not only P, but the co-operation of G, H and I. An arbitrary number of modifiers have been chosen in order to illustrate the difficulties involved. In some cases even more modifiers may accompany the basal factor for colour of the corolla.

The required combination is:—*y a b c* S D E F P G H I.

The first cross of Upland by Peruvian produces an F_1 with all the above genes in a heterozygous form. By self-fertilisation the required combination appears once in nearly 17,000,000 times, and it would be virtually impossible to pick it out. Let us endeavour to take a short cut:—

First Step.—Back cross the F_1 to Upland and pick out the types with the exact shade of Upland corolla. If four factors are involved, one plant out of 16 will be *y a b c*. It should be easy to select a type with S (spot) and P (yellow pollen) so that we have now obtained:—

y a b c S— — — P— — — Extraction 1.
y a b c s— — — *p*— — —

The modifiers of S and P are indicated by dashes, as nothing is known of their presence or absence except that higher grades of S and P are likely to contain more modifiers.

Second Step.—Self extraction 1, and obtain a *y a b c* SP homo for S and P (one out of 16 strains). Call the resulting strain extraction 2.

Third Step.—Cross highest grades of S and P in extraction 2 with Peruvian and select plants with highest grade S and P, giving extraction 3.

Fourth Step.—Cross extraction 3 with any plant shewing high S and P in extraction 2 and select again a plant—*y a b c*. Call the plant extraction 4.

Fifth Step.—Self extraction 4 and pick out highest *y a b c* for S and P, giving extraction 5.

Sixth Step—Cross extraction 5 with Peruvian and back-cross to extraction 5.

Seventh Step.—Pick out *y a b c* plants and self. Some should now be genetically of required type. As a matter of fact even after carrying out these seven operations we should not get what we set out to obtain, for the factor Y for yellow corolla acts as a modifier (intensifier) of petal spot, although the resulting strain would have the required genetic composition. How certain factors or factor combinations affect the expression of other factors is one of the future tasks of the cotton geneticist.

Carver (*Journ. Amer. Agron. Soc.*, Vol. XXI, No. 4 pp. 467-480) deals with the results of crosses between different varieties of Upland cotton. He describes the mode of inheritance of certain leaf and seed characters, involving seven factor pairs. These are as follows:—

Factor pair.	*Contrasting characters.*
1 O - o	..Okra leaf—normal leaf.
2 R - r	..Red leaf—green leaf.
3 B - b	..Buff anther—white anther.
4 Br-br	..Brown seed fuzz—white seed fuzz.
5 G - g	..Green seed fuzz—white seed fuzz.
6 N - n	..Naked seed—entire fuzzy seed.
7 Ft-ft	..Fuzzy tip seed—entire fuzzy seed.
8 S - s	..Spot—spotless.

Of these factor pairs Nos. 4, 5 and 7 have not previously been described. No. 3 is apparently identical with the well-known factor P for yellow pollen of Peruvian merely lacking the intensifier Q. The author's results may be summarised as follows:—

Naked seed and fuzzy tip seed behaved as simple Mendelian dominants to entirely fuzzy seed. Naked seed was dominant to fuzzy tip and the F_2 ratio was observed to be 12 naked : three fuzzy tip : one fuzzy. Green seed fuzz and brown seed fuzz were dominant to white seed fuzz, with simple mono-hybrid segregation in F_2. Green seed was dominant also to brown. The exact inter-relation of green, brown and white was not demonstrated. Linkage relations between red, petal spot, naked seed, and buff anthers were sought for, but all these characters were apparently independently inherited. It is somewhat surprising to find red and petal spot independent, since the reviewer, in crosses of red leaf Peruvian and Bourbon with Upland, has found strong linkage between R and S, the two genes being only about five units apart on the chromosome. It is therefore possible that the red leaf of Upland is genetically distinct from the red of Peruvian or Bourbon.

WEST AFRICAN CONFERENCE.

The second West African Agricultural Conference was held in the Gold Coast from 16th October to 5th November under the Chairmanship of Mr. G. G. Auchinleck, Director of Agriculture, Gold Coast. There were three sessions, the first at Accra, the second at Kumasi, and the third at Sekondi. The Administrative Committee consisted of Messrs. F. A. Stockdale, O. T. Faulkner, H. C. Sampson, F. J. Martin, A. J. Findlay, G. G. Auchinleck and H. B. Waters. There were, in addition, eight Sub-Committees which were appointed to formulate proposals for the West African Colonies with regard to problems related to economic botany, agricultural chemistry and education, entomology, meteorology, produce inspection, statistics and rural economics. A number of important papers were read. The subjects open to general discussion included the West African cacao and oil-palm industries, the compulsory certification of export produce, the development of new agricultural industries in West Africa, and the resolutions of the administrative and Sub-Committees. The Administrative Committee considered, amongst other things, the investigational programme of the Gold Coast Department of Agriculture; departments of agriculture and agricultural research; investigational work on soils and the resolutions passed at the first West African Conference; the relation with Imperial Bureaux; the study of the economics of peasant agriculture; mycological work; the Kumasi Headquarters scheme and the stimulation of the oil-palm industry.

A NOVEL EXPERIMENT STATION.

In a paper read before the Agricultural Section of the Indian Science Congress, in January of this year, Mr. R. D. Anstead, the Director of Agriculture in Madras, while describing recent agricultural development in that Presidency, called attention to a special situation which his Department had had to meet and which, only a few years ago, would have seemed most unlikely.

The position in Madras is that the energies of the Department for the last 20 years, in the direction of supplying good seed of improved strains, and in inculcating improved agricultural methods, are beginning to bear fruit, so that yields of rice as well as of other crops are being considerably increased. This has implied an extra drain on the plant food in the soil, and now the amount of phosphorus and nitrogen available is becoming, in many cases, the limiting factor of crop production. Agricultural Departments have been alive to this danger for some years; there was a strong move in 1917 to prohibit the export of phosphatic manures, which unfortunately failed. Nitrogen, in any case, must be imported, as there is not enough cattle manure to go round.

Simultaneously with this increasing need for artificial manures, has occurred the very marked reduction in their price, with the result that the *ryot* has suddenly awakened to the possibility of their use, and is ready to buy them. Over 3,000 tons of Sulphate of Ammonia alone, were purchased last year. Unfortunately, this demand is not only being met by reputable firms, but is being exploited by a host of propagandists and petty importers, who advertise a wide range of manures such as Sulphate of Ammonia, Calcium Cyanamide, Nitrate of Soda, Nitrate of Potash, Ammonophos, Leunaphos, Nitrochalk, to the bewilderment of the buyer. Naturally, he turns to the Department for advice, but it is unfortunate, as Mr. Anstead points out, that his Department can do nothing to help, for they themselves know little about these new fertilizers, and as yet have had no time to experiment with them. Mr. Anstead is determined that this reproach shall no longer be levelled at his Department, and accordingly has arranged an experiment station on a quite novel plan. The station will be subsidised by the manure firms themselves. A careful estimate of the cost of each trial has been worked out, and each firm will pay a subsidy as a proportionate share of the total cost, based on the number of trials which they wish to have made. The Department will carry out the work, and the trials will be conducted according to the latest methods over a period of five years, when the results will be published.

The simplicity of this scheme commends itself, and though it is unlikely that such a situation will arise for some time in many of our Tropical Colonies, the peasant has a habit of moving quickly once he is convinced, and a similar position to that outlined above might easily develop elsewhere.

R. C. W.

SOIL EROSION.

THE October issue of the *Empire Cotton-Growing Review* draws attention to an address on the development of tropical countries which was delivered recently at the annual meeting of the Cotton Corporation by Mr. Stockdale, the Assistant Agricultural Adviser of the Colonial Office. One of the most important aspects of the subject brought up during the address was that of soil erosion. This proceeds at a much quicker rate in the tropics where the rainfall, being very much heavier, than in the temperate countries, rapidly washes away the surface soil and leaches out the lower layers so that in a few years after clearance, the richest forest land may be reduced to the poorest possible condition.

The natural state of most of the land in the rainy countries of the tropics is to be covered with forest or coarse grass. In either case it is useless for general agriculture, but its soil is at the maximum degree of content of humus, plant food and water-retaining capacity (largely due to the humus) that occurs under natural conditions. These features—which, as everyone who works with agriculture in the tropics knows, soon diminish and largely disappear after clearance of the land—are the natural capital of the country. This capital should be conserved, not regarded—whether consciously or unconsciously—as something to be exploited until perhaps the land at the last must be abandoned (as may be seen in many places). The real question is, how to get the best out of the land without destroying the natural capital more than can be helped.

It is possible to live almost entirely upon the capital value of forest land, and this is the underlying explanation of the type of cultivation known in Ceylon as *chena*, in India as *jhuming*, in Malaya as *ladang*, and by other names in other countries. It is found almost all over the world where population is thin enough to allow to each person a large area of forest land. The trees on a portion of this are felled and burnt, and on the rich forest soil, further improved by the ash, a couple of crops of cereals or other products are grown, and the land is then left to go back gradually to forest: it is again good enough to *chena* in 10 to 50 years.

This is living upon capital purely and simply, for the land is abandoned as soon as it begins to become weedy, in order to avoid the labour of real cultivation. It is less trouble to *chena* a fresh piece of land. If population increases, however, as it has done for example in much of India and Ceylon, *chena* must perforce be given up and more real cultivation carried on. But this has, in such countries, to be done upon land where the natural capital, owing to reckless clearance, has been very much reduced. The result is poor and uncertain crops, varying considerably with the climate of the particular year.

In districts where pressure of population has compelled people to take more care, attempts have been made to rectify this state of things, by green manuring, rotation of crops, mixture of crops, and even by the use of actual manures, though, in general, cowdung, which is almost the only available and cheap manure, is used as fuel and so is largely lost. But there are distinct and recognizable attempts to put back something into the soil, or to equalize and minimize its rate of loss.

A state of things which is essentially very similar to this may be seen in most tropical regions opened up by Europeans in coffee, tea, &c. Largely through ignorance, they have used up the natural capital of soil, humus, &c., almost as rapidly as possible. Their planting of various crops has largely proceeded in "booms," in which there has been an insistent demand for land, and not sufficient foresight or knowledge on the part of the Government to curb this demand in the interests of future generations.

The result has been wholesale opening of land, usually in hilly country, where erosion proceeds rapidly. The heavy rainfall has caused tremendous erosion and leaching, and has led to the silting up of rivers, causing floods and stoppage of navigation. A heavy price has frequently to be paid by a country that has been opened up for planting—not so much at the time, as later, when the results of the mistakes that were made in earlier times begin to appear.

Just as with the native industries above mentioned, so the planting industry has been forced to resort to the use of manures, of green manures, of terracing to prevent wash, of drainage, and so on. But the Government can and should also assist, for example, by the provision of sufficient reserves of forest. In Ceylon, in early days, small strips of forest were left along the tops of the ridges, but they were so narrow that they were soon consumed for firewood, burnt, or otherwise rendered nugatory. However insistent be the demand for land, the Government should enforce the reservation of large areas in forest, in such a way as to prevent erosion (so far as possible), or the drying up of the streams in hot and dry weather, a common occurrence in such countries as Ceylon, where it adds greatly to the difficulties of water supply.

The provision of an officer for general service in the tropical and subtropical colonies, to deal with this whole question of prevention of erosion and of deterioration of soil, is quite worth the consideration of Government. But if appointed, he should spend a good deal of time in study both within and outside of the Empire, to see how the matter is dealt with, for example, in Java by terracing, &c., in China and Japan by use of manure, &c., and in other countries in other ways. He should establish liaison with forest and irrigation officers, with engineers in charge of roadmaking and others, and eventually with their assistance devise definite schemes for road, drainage, and forest reservations, and for all such matters which concern several departments (and which must therefore be carried out

by definite orders from Governmental headquarters), in addition to working at the questions of manuring, green manuring, &c., which are the province of an agricultural department.

Nearly all countries which have been opened up for any kind of "planting" afford striking object lessons in what ought *not* to be done, and the newer colonies should profit by these lessons before it is too late, and should learn what *ought* to be done, and do it.

GROUND-NUTS.

Production in the Gambia.

THE first bulletin of the Gambia Department of Agriculture is entitled "The Cultivation of Ground-nuts" and has been compiled by A. J. Brooks, F.L.S., F.C.S., Director of Agriculture. The bulletin deals with the groundnut crop essentially from the point of view of its production in the Gambia but a number of points arise which are of general interest elsewhere and the following notes have been extracted from the publication.

Ground-nuts have been grown in the Gambia for many years and form the only export crop of the Colony. Accordingly their production and problems arising in connection with it have received considerable attention from the Agricultural Department.

The crop is grown entirely by native peasant farmers under climatic and soil conditions which vary considerably, the growing season being during the rainy period—June to October. Formerly the trailing type of ground-nut was the only one grown in the Colony. This produces nuts along the stems whereas the erect type which has lately been introduced bears its nuts in a cluster at the base of the main stem. Definite varieties have been imported and some have succeeded in trials sufficiently to justify their general distribution.

The importance of regarding the weight of nuts as well as their size when selecting for seed is stressed, and it is pointed out that a common error throughout the colony is sowing too soon. Second and third seedlings are often necessitated on account of the plants from the earlier sown nuts having been killed by a short drought in the early part of the rainy season. The crop occupies the land for three to four months, according to variety; there is, therefore, ample time for the plant to develop fully and mature by the beginning of the dry season. As a general rule the optimum sowing period is stated to be 1st to 15th July.

Where the soil is heavy and liable to become water logged ground-nuts should be grown on ridges, but on lighter well drained soil, sowing on a flat surface has given better results.

Nuts should not be shelled until immediately prior to sowing and then a final selection of suitable seed should be made. The best spacing for the *erect* type is found to be 6 ins. x 18 ins., whereas 16 ins. x 24 ins. is suitable for *trailing* varieties. Two seeds are planted to each stand at a depth of about one inch.

The land should be kept clean and the soil loose until the flowers begin to fall and the "pegs" commence to penetrate into the ground. Grass and weeds prevent the stems spreading over the soil, and under such conditions the "pegs" wither and produce no nuts.

The correct stage for harvesting is indicated by a yellowish-green appearance of the plants, but a satisfactory test can only be made by uprooting a number of plants in different parts of the plot.

Harvesting is carried out by hand; the soil is first loosened around the plants which are then uprooted and overturned so that the nuts adhering to them may have an opportunity of drying for two days before being stacked. Obviously, fine weather is necessary for this operation.

The following paragraph explains the next procedure:—

"It is now the general custom to stack the nuts while curing on temporary platforms erected in the field made from bamboos or rhun palms. The cross sticks forming the base of these platforms should be spaced as wide apart as practicable to admit a free circulation of air and should be raised at least two feet from the ground. The more open the stack is kept the quicker will the curing be effected and the less likelihood there will be of moulds developing. The top of each stack should be covered with a grass mat to prevent the nuts becoming wet from an occasional light shower or from heavy dews. *Should the nuts become wet the stacks must be opened up at once* and the nuts spread out again in the sun."

Neglect at this stage gives rise to the rapid development of heavy black moulds bringing about serious loss.

Of the factors influencing yield *clean weeding and sowing at the right time* are the two most important within the control of the grower. Average yields on native farms are 800-900 lb. of unshelled nuts per acre. On the Government Farm at Cape St. Mary yields between 1,000 and 3,000 lb. have been obtained from different varieties.

Two diseases are common among ground-nuts in the Gambia, namely "Rosette, or Virus disease" and "Leaf Spot." "Rosette" is the more serious and is transmitted by an insect carrier. Infection may be carried on from nuts left in the soil the previous season, and the effect on the plant is to stunt its growth, the young leaves turning white or yellow with dark green blotches. The crop is considerably reduced, and seriously affected plants are rendered barren. As a control all diseased plants should be burnt as soon as they are found, and "volunteer" ground-nuts, in land that was known to have carried a diseased crop the previous season, should be uprooted and destroyed. Attention is being given to raising immune varieties.

Plants attacked by leaf spot develop on their leaves bright yellow markings with dark brown centres. Damage is not normally great, and crops planted before the middle of July are the least liable to attack.

The legal standard for the export of groundnuts in the shell from West Africa, is a content of not more than two per cent. by weight of dust and foreign matter including empty shells. An allowance must be paid by the seller for anything in excess of this figure. Similarly an allowance is payable whenever the shells exceeds 25 per cent. of the total weight of the sample. "Light" nuts, *i.e.*, where the proportionate weight of shell exceeds 25 per cent., may be the result of a number of different factors—unsuitable climate, disease and insect pests—but the main attributing cause in this respect lies in harvesting the crop before the nuts are mature.

Penalties are also provided for the inclusion of "bad kernels" in the marketed produce. These reduce the value of the oil extracted from the nuts and are usually the outcome of too wet spells during the ripening period or through rain falling on the crop in the stack following reaping. A good deal of adulteration with dried earth is practised by the grower and five years ago compulsory screening on the part of the exporter was introduced. In its first year, 1924-25, this introduction was largely responsible for the reduction of the total figure for the annual export of groundnuts but since that year the exports have increased steadily from 46,583 tons in 1924-25 to 75,386 tons in 1927-28.

D. B.

ARTIFICIAL MANURING OF PADDY.

An account of some manurial trials on paddy in Lower Burma is given by D. Hendry, M.C., B.SC., N.D.A., in the *Agricultural Journal of India*, XXIII, 5. The objects of the trials were (1) to determine the most favourable nitrogen—phosphorous ratio for fertilisers used on paddy, (2) to determine the amount of the optimum application for such a fertiliser, (3) to compare the effects of mixtures of Sulphate of Ammonia and Superphosphate with the effects of equivalent amounts of Ammo-phos, Diammonphos, and Leunaphos, (4) to determine the residual effects of the fertilisers in the year after the application.

The results of the experiments were compared both by determining the actual percentage increase in grain and straw yield over untreated plots, and by calculating the monetary net profit accruing by the use of the fertiliser. In many cases the increase in grain yield was insufficient to provide for the cost of the additional fertiliser. Thus an application of 200 lb. of Ammo phos per acre gave a yield of grain greater by 103 per cent. than that of an untreated plot and a net profit of 24 Rs. 6a. An application of 300 lb. per acre gave a yield greater by 118.6 per cent. but the cost of the additional 100 lb. of fertiliser per acre reduced the net profit to 20Rs. 15a. Therefore, in deciding the optimum application and type of fertiliser, the value of the net profit obtained was used. In calculating the value of the crop, the value of the straw produced was neglected, since, under local conditions, it was valueless. In other districts, the increased straw yield might be an additional source of profit.

The influence of the N : P ratio on the yield was determined by comparing plots treated with 20/20 and 13/48 grades of Ammo-phos. The former grade not only gave an increase in yield of grain of 103.4 per cent. as compared with an increase of 67.9 per cent. from the latter grade, but also its cost was lower. More elaborate experiments showed that the highest crop yields were given by fertilisers having an N : P ratio of 1 : 2 and 1 : 3. The greatest profit, however, was obtained from those having the nitrogen and phosphate in the ratio 1 : 1.

The optimum amount of all the types of fertilisers to apply under the conditions of the experiments appeared to be between 200 lb. and 250 lb. per acre. Greater applications were unprofitable.

A comparison of yields obtained from equivalent applications of Sulphate of Ammonia and Superphosphate mixture, Ammo-phos, Diammonphos and Leunaphos showed there was no significant difference. The lower cost per unit of the nitrogen and phosphorous in the fertilisers of the ammonia phosphate type allowed for greater financial return.

Plots which were cropped a second year with no further treatment showed a greater yield than the untreated plots. As would be expected, the fertilisers with the greatest content of phosphorous showed the greatest residual effect. The plot treated with 200 lb. per acre of 20/20 Ammo-phos gave, in the second year of cropping, a yield greater by 12.0 per cent. than the untreated plot, while the plot treated with 200 lb. per acre of 13/48 Ammo-phos gave a yield 22 per cent. greater. This larger yield, however, was insufficient to warrant the greater initial outlay on the 13/48 grade.

Summarising, the most profitable fertiliser for paddy was found to be one of the ammonium phosphate type containing equivalent quantities of nitrogen and phosphorous applied at the rate of 200 to 250 lb. per acre

The results quoted here, are strictly applicable only to the district, soils and general conditions in which these trials were made. They may, however, give valuable assistance to experimenters wishing to make less elaborate trials.

H. H. C.

CANE CUTTING MACHINE.

Promising results are reported to have been obtained with the Miller-Owen cane cutting machine in Queensland. A demonstration is reported to have shown that burnt cane can be cut by a self-contained unit operated by one man, and better than can be cut by hand, the rate being 5 tons per hour. The machine is in the hands of the Mackay Cane Harvester Co., Mackay, Queensland.—(*I. S. J.* 31. 369, p. 508.)

TROPICAL WORLD NOTES.

Federated Malay States.

According to the *Report* for 1928 by the Chief Secretary the year was characterized by an increasing and in some cases very practical interest in the cultivation of crops other than rubber, the price of which fell from 68 cents per pound in January to 32 cents in April when Restriction was removed, eventually closing at 29 cents in December. In spite of the failure of rubber, however, large quantities of budwood, budded stumps and selected seed for obtaining high-yielding rubber trees were imported from Java and Sumatra by plantation interests. A new development was the creation by an American Corporation, interested in the manufacture of rubber seed oil, of a market for rubber seed, the price offered for this providing a good margin of profit to most estates. It is hoped that this trade will be further developed and will lead to the erection of a decorticating plant in Malaya, as all the seed purchased was exported to Medan in Sumatra, where the Corporation's decorticating plant is situated. The investigations relating to the preparation, deterioration on storage and moisture content of *jelutong* have enabled a marked improvement to be effected in the quality of the Malayan product, resulting in increased exports.

The figures for rice represent a decrease of about 500 acres in the planted area but an increase in crop of approximately 7½ million gantangs* of which nearly half was obtained from the irrigation area in Krian where the yield for the year was only slightly below the average for the last decade. Selected strains of Krian padi continue to give satisfactory results in comparison with local varieties. Experiments designed to obtain information on the possibilities of storing rice and padi as a reserve for use in any period of shortage have been commenced. It has been shown that under varying conditions the moisture content of rice has increased with the arrival of the wet season.

The coconut crops were satisfactory in most districts. Amongst experimental investigations which are being carried out on this crop, further data are being collected on the oil content of copra from different palms and on the seasonal variation in the oil content of copra for the same palm. A scheme for research on the preparation of copra has been approved, the Empire Marketing Board providing half the cost. Satisfactory progress has also been made in the development of the palm oil industry, the Malayan palm oil commanding a premium above the market prices on account of its purity. Variation studies of palm fruits, comparisons of factory methods and oil storage problems form the main lines of investigation.

Much interest is being displayed with regard to the prospects of the cultivation of pineapples coffee, tea and tuba root, the latter being used in the preparation of proprietary insecticides.

* 1 gantang equals 32 gallons.

A Government Experimental Station with a total area of 800 acres inclusive of a site for the proposed School of Agriculture, has been opened and experimental palm oil and tea factories are in the process of being erected.

* * *

French North Africa.

An interesting sketch of the history of the olive in North Africa from early times, and of the great development which its culture has attained in recent years, is given by MM. Payen and Ladreit de Lacharrière in the *Renseignements Coloniaux*, 1928, No. 6. All the early travellers and writers, classical and Arab, bear witness to the importance of the olive harvest in their times. The Arab invasion ruined the industry for a time, but it regained ground, and in the Turkish period a large trade in olive-oil, direct or indirect, was done by Marseille, most then coming from Tunis, for the export from Morocco was for some time interdicted. After the French conquest of Algeria, improved methods of cultivation were slowly introduced, but development was delayed for a time by the slight encouragement given by the home government. In Tunis olive cultivation was at a low ebb in the time of the later Beys, and it was some time after the French occupation before any great development ensued. The flourishing nature of the industry in the protectorate to-day may be ascribed almost entirely to the energy and enthusiasm of Paul Bourde, who, calling in the aid of native cultivators, established thriving plantations which so altered the position that production has assumed great proportions. This is especially true of Sfax, where the number of trees had more than trebled between 1896 and 1926. In Algeria there has been a steady though less marked increase in the number of trees since the beginning of the century, though the figures for the production of oil show a good deal of fluctuation, due in great measure to the occurrence of good or bad seasons. The memoir is accompanied by a map showing the distribution of olive culture in French North Africa. Although the olive is par excellence the tree of the Mediterranean regions, and shows extraordinary vitality even when the circumstances are unfavourable, the regions of greater abundance are somewhat widely scattered. In Morocco there are four, separated by tracts in which the tree almost disappears; and in Algeria the department of Oran shows much smaller areas than Algiers and Constantine, where more or less homogeneous tracts extend for some 200 km. south of the coast-line. In Tunis the olive habitat stretches continuously from west of Bizerta to near Gabes, though here as elsewhere intensive culture is localized in certain districts. Although the modern development has been mainly due to the establishment of artificial plantations, a good deal of the produce is still derived from the wild trees, especially in Morocco.—(*The Geographical Journal*, Vol. LXXIII, No. 1.)

ENTOMOLOGICAL NOTES.

Compiled by the College Department of Entomology.

The Mediterranean Fruit Fly.

The object of this note is to examine briefly American methods of control in dealing with the Mediterranean fruit fly which, as will be remembered, invaded Florida early last year, in spite of rigorous quarantine services. The life history and habitat of this very destructive pest have already been discussed in this Journal* and will not, therefore, be referred to again.

The Florida citrus crop season was at its highest and large quantities of fruit had already been shipped when the Mediterranean fruit fly was discovered. The United States Government, however, immediately formulated a policy of eradication, put into effect the necessary quarantine regulations and provided the funds to organise a campaign against the pest. Fortunately for them, there are indications that the outbreak was well localised and was due to a very recent introduction.

Quarantine was declared at once against the State of Florida and all localities, including a strip one mile wide outside the fly area were declared infested zones. These, in turn, were surrounded by protective zones nine miles wide. Within the infested zones all fruits and vegetables known to be liable to attack by the fly were destroyed and no fruit, vegetables, soil, peat or manure, were allowed to be removed. Further, no railway cars, vehicles or conveyances of any kind were allowed outside these areas without being inspected and treated. Meanwhile, a lookout accompanied in some districts, by search and inspection, is being kept throughout the United States, for the appearance of the insect in new localities. The Southern States and parts of the South Central regions are being watched particularly carefully as this is where it is known that natural advantages might help the fly to become established. The adult fly has been found in several places to which infested fruit had been shipped from Florida before the quarantine restrictions were imposed but in none of these places has the insect been found to be breeding. No anxiety is being felt about the north-eastern and northern states which are being regarded unsuitable climatically, for the fly. The thoroughness with which last year's campaign has been conducted has been a temporary safeguard against the introduction of this insect from American sources.

Several proclamations were issued in the West Indies as soon as it was learnt that the fly had made its appearance in Florida. These islands, being most of them, so near each other and subject to much traffic, are particularly liable to the invasion of pests and diseases. Specially is this the case in the smaller groups of islands where there are no trained produce inspectors. Dependence in such instances must be placed on prohibitions and restrictions, in the case of products coming from places where pests are known to exist; and certificates of inspection and of origin, in the case of imports coming from localities where there are no known pests likely to be introduced. Plant products, intended for food consumption however, come under a somewhat different category than plants, cuttings, seeds, &c., intended for propagation.

There are at the present time in the West Indies legislative enactments sufficient to allow for the necessary restrictions on importation; there are also specific and general restrictions in force to give as complete a safeguard as possible against the introduction of the fly. Some of these, however, include provisions with regard to plant products which might be exempted. At the Conference of Agricultural Officers to be held at the Imperial College of Tropical Agriculture this month, legislation regarding the importation of plants and animals with the object of preventing the introduction of pests and diseases will come under discussion. It is hoped, that in general, regulations may be recommended in order that uniform action may be taken by the Governments of the several Colonies and Presidencies of the British West Indies. Foreign possessions in the Caribbean may also be asked to co-operate in this matter.

* *Tropical Agriculture* Vol. VI, No. 9, page 254.

1930 POULTRY CONGRESS.

The Fourth World Poultry Congress will be held at the Crystal Palace, London, England, from 22nd July to 30th July, 1930. The British Government cordially invites all persons interested in any aspect of poultry husbandry in any part of the world to be present.

The Congress is being organized by the British Government. It will be held under the distinguished patronage of His Majesty the King, Her Majesty the Queen, and His Royal Highness the Prince of Wales.

In connection with the Congress an Exhibition will be organized comprising:—

(1) national exhibits staged by participating countries;
(2) exhibits of poultry, rabbits and pigeons entered by breeders from all parts of the world;
(3) commercial exhibits of interest to the poultry industry.

Information regarding entry fees for exhibitors and membership charges for delegates, together with plans and all other particulars concerning the Congress, may be obtained free on application to the Secretary, World Poultry Congress, 10, Whitehall Place, London, S.W.1, England.

PUBLICATION FOR SALE.

Copies of *Insect Pests of the Lesser Antilles*, by H. A. Ballou, price 2*s*. 6*d*. can be purchased on application to the Editor, *Tropical Agriculture*.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Pressure Evaporation in Cane Sugar Factories. P. HONIG AND J. F. BOGTSTRA. *Archief, deel III, Med.* 1929, No. 14, 689-834.

In the introduction a survey is given of some previous work in Europe on pressure evaporation in connexion with beet juices (1), after which follows an account of the experiments carried out lately in the Soemberdadi and Kentjong factories with the object of examining the results with cane juices clarified by the sulphitation process, this work supplementing a previous report on the subject (2). A standard triple effect was used, the juice temperatures being respectively 114, 108 and 102° C., and a special juice level regulator recently patented by Boulogne was installed. Analyses of the juices entering and leaving the bodies made continuously during the trials showed that, provided that the tubes are clean, no drop of the purity or glucose-ratio can be detected while the density is being raised to 50° Brix. Nor was there any marked colouration of the juice, though it was observed in pressure evaporation that the acidity increased, due probably to the decomposition of non-sugars. But here with sulphitation juice the incrustation formation was the difficulty, much more so than in the carbonatation trials already reported (3), and this had a great effect in lowering the capacity of the apparatus. True that the addition of ¼ per cent. of infusorial earth to the evaporator juice wholly altered the physical nature of the incrustation, making it softer than usual; but this modification appeared yet more to lower the transmission. Although on the whole the amount of incrustation in the pressure apparatus was only a little greater than in the factory evaporator, the effect in the former case is of more importance, seeing that a pressure evaporator must work at its full capacity to avoid juice decomposition. Pressure evaporation, therefore, cannot be recommended in dealing with sulphitation juices, the prevention of incrustation not being possible. An incidental point in connexion with the examination of the incrustations is that those from the pressure apparatus were found to contain more magnesium oxide than the others. Another part of this contribution deals with experiments made with the experimental evaporator designed by the French engineer Orth (4) and a point emerging from these, and an interesting one, is that an acid or a slightly alkaline juice of 20° Brix can be heated for a comparatively long time at 110° C. without any modification either of the purity or of the glucose ratio being detectable. Juice at a pH of 5.9, for example, was heated 18 min., at 110° C., without these figures being affected. In explanation of this, it is suggested that the temperature coefficient of the pH may be different for different juices. In general the position in regard to pressure evaporation in cane factories appears to be that with carbonatation, sulphitation and defecation juices, triple effect evaporation under pressure with 114° C. in the first body, causes during concentration to 50° Brix no more sucrose and glucose decomposition than in vacuum evaporation, provided the concentration takes place during a time not exceeding 9 min. and at the correct reaction. Probably concentration to 60° Brix can also be effected under the same conditions. Incrustation of the tubes must be avoided. With carbonatation juices this can be realised sufficiently by combining a correct clarification, a proper thin-juice sulphitation, and a good circulation in the evaporator bodies. But with sulphitation and defecation juices, owing to the impossibility of preventing incrustation to any marked extent, pressure evaporation cannot be advised.—(*Int. Sugar Journal,* Vol. XXXI, No. 370).

(1) *I.S.J.*, 1929, 36, 89, 154.
(2) *I.S.J.*, 1928, 329, 1929, 121.
(3) *I.S.J.*, 1929, 212.
(4) *I.S.J.*, 1927, 166.

* * *

Separate Purification of the Last Mill Juice.—P. HONIG, *Verslag v.d. Chemische Afd. V.h. Proefstation (Java)*, 1928.

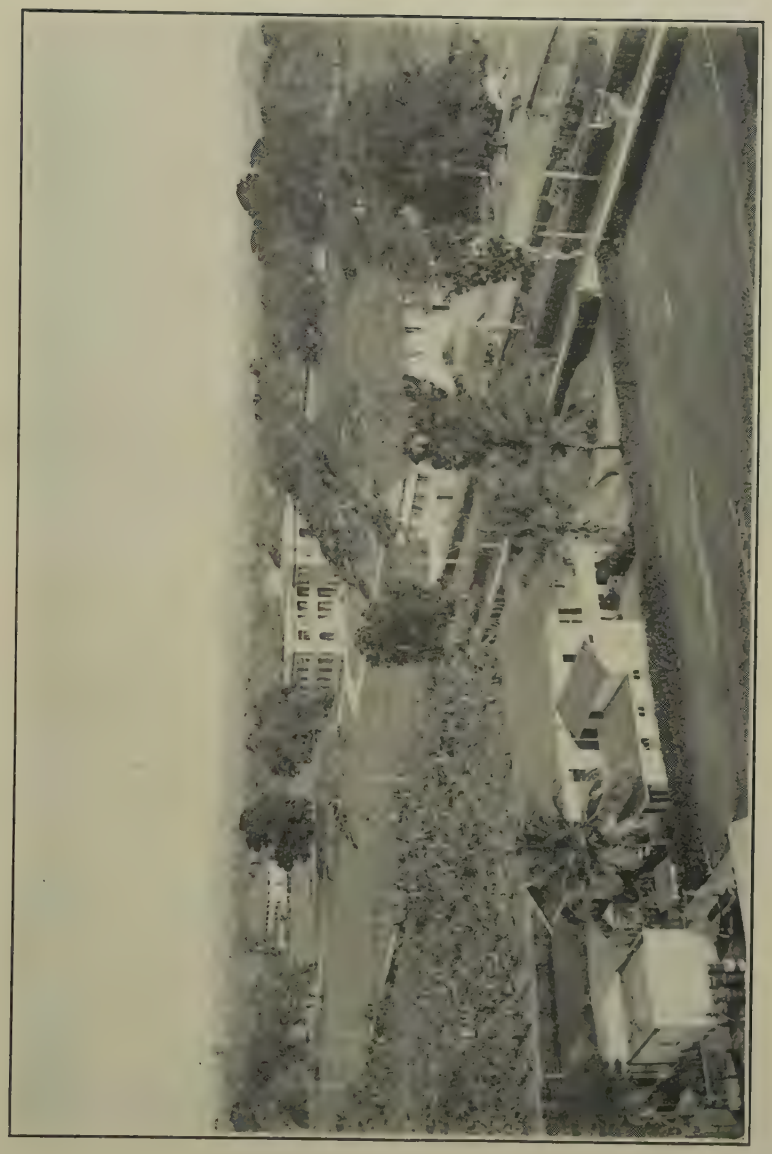
At a Java factory, investigation was made on a separate purification of the juice from the last mill, with the idea of seeing whether such a procedure would diminish the amount of lime and sulphur required to purify the rest of the juice. In this test the last mill juice was collected in separate tanks instead of being directly mixed with the first juices and was made alkaline with milk of lime (pH 7.8 for sulphitation and pH 7.4 for defecation) and the juice filtered; an increase of about 2° in purity was obtained. The results showed that in a factory where in an 8-hour shift 5,625 hectolitres of raw juice and 477 hectolitres of last juice were being obtained, the lime consumption (in the form of 13° Be. milk of lime) of the factory could be reduced from 1.4 per cent. to 1.0 per cent. by this separate treatment of the last juice. This saving amounted to 7,322 litres of milk of lime, or 28.6 per cent. of the usual quantity, and there was a corresponding saving of sulphur.—(*Facts About Sugar,* Vol. XXIV, No. 43.)

* * *

Molasses as Fertilizer.

In Hawaii work has been carried out of late on the utilization of molasses as fertilizer, and mixings of this by-product with bagasse, filter-press cake, furnace ashes, and the like (so-called "Molash cake") have been found to give favourable results.—(*I.S.J.*, Vol. XXXI, No. 370.)

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.



This photograph, which was taken from the chimney top of the Sugar Factory, shows the Milner Hostel (extreme left), the Main Building, the Biological Laboratory and the Banana Plot.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

The new Chemistry Laboratory, part of the College Farm (in background) and some of the Experimental Plots.

Panoramic view of part of the Northern Range taken from College Sugar Factory. Part of Cotton Research Station Farm (middle foreground).

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Nitrogenous Fertilizers and Rice.

Experiments on the assimilation of nitrogen by rice cultures are described by Dr. R. P. Bartholemew in *Soil Science*, Vol. XXIX, 1929, pp. 85-100. Various fertilizer substances were tested under anaerobic conditions. Amongst these, ammonium sulphate, Jenna saltpetre, cottonseed meal, sodium nitrate, blood meal and ammonium phosphate proved reasonably efficient in the order named, whereas calcium cyanamide, and mixtures of calcium or sodium nitrate with cottonseed meal were much less satisfactory. The organic nitrogenous substances tested suffered considerable losses of nitrogen through bacterial denitrification. Indeed, all the materials examined showed some loss of nitrogen through denitrification. Sodium nitrate gave rise to an alkaline condition, which exerted a depressive action on rice growth. The formation of nitrite as an intermediate stage in nitrification was small and irregular.

* * *

Artificial silk and sugar-cane bagasse.

That the waste bagasse from sugar-cane is still regarded as a potential source of cellulose for the production of artificial silk is shown by a recent British patent. The patent covers the manufacture of artificial silk from cellulose which has been produced from bagasse. The method used for the production of the pure cellulose from bagasse was patented in 1927. It consists of extracting the bagasse with calcium hydroxide solution. The residue is digested under pressure with dilute sodium hydroxide and sodium sulphite solution for from four to six hours. The cellulose so produced can now be rendered suitable for conversion into artificial silk.

If the method is a commercial success it will need considerable organisation of the supplies of raw material before the process becomes a significant factor in the sugar industry.

* * *

Bamboo in Paper Making.

At a meeting of the Colonial-Economic Committee, Dr. Carl G. Schwalbe, of Eberswalde discussed the question of the exploitation of tropical fibre plants. A dearth of paper is threatened because of the present enormous consumption and the lack of sufficient raw materials. Paper is obtained to-day almost exclusively (90 per cent.) from spruce wood, and its production from other woods, such as pine or beech, would require many expensive changes in the methods of manufacture. Professor Schwalbe now proposes the use of bamboo, which has proved successful for about 20 years at the Indian experiment station Dahra Dun. Bamboo fibre could replace the spruce wood fibre, which has been used almost exclusively heretofore. Because of the rapid growth of bamboo, it appears to be the most suitable fibre plant of the future, not only for the tropics, but also for the countries of the temperate zones. For the latter Professor Schwalbe recommends the production in the tropics of a refined bamboo material, a bamboo concentrate so to speak, hemicellulose, and then its shipment to the sulphite cellulose factories in the temperate zones for use in place of spruce wood, the supply of which is constantly decreasing.—(*Industrial and Engineering Chemistry, News Edition*, Vol. VII, No. 16.)

* * *

Liquorice root.

An article on the little known Liquorice industry is published in the *Industrial and Engineering Chemist*, 915, XXI.

Commercial liquorice is extracted from the root of the liquorice plant (*Glycyrrhiza glabra*). This sub-tropical plant is cultivated by the peasants of the Mediterranean regions, of Asia Minor and Southern Asia. Fertile river soils are generally used. The plant is a shrub and may reach two to three feet in height. The roots have a maximum diameter of one inch and may have a length of 25 feet.

These roots are dug at the correct season and transported to a central station where they are cleaned, sorted and stacked in heaps. The curing process which occurs in the stacks is allowed to continue through the following summer. Drying and curing are promoted by turning the stacks frequently and covering in wet weather. The dried roots are finally pressed into bales and shipped to American factories.

In the factory, the bales are broken and the roots shredded and extracted with water under low pressure steam. The valuable sweet principle is Glycyrrhin for which frequent tests are made during the extraction. The extract is allowed to settle, when active fermentation occurs. After a definite period, the clear liquid is separated and concentrated in vacuum pans. The concentrate is either dried completely and the residue powdered, or left as a thick paste which, on cooling, gives the familiar semi-plastic black mass.

The majority of the liquorice is used in the tobacco industry as a flavouring, sweetening and blending agent, or to maintain the moisture of the tobacco. It is applied by spraying or dipping the dried leaves. The remainder of the liquorice produce is consumed by the pharmaceutical and confectionary trades.

Several by-products of value are obtained during the manufacturing process. The spent extracted root is re-extracted with five per cent. sodium hydroxide. The concentrated extract is used as a foam stabiliser in foamite. The remaining root fibre is dried and compressed to make cardboard, wall boards and insulating boards.

OBITUARY.

PROFESSOR T. B. WOOD.

It is with deep regret that we have learnt of the death, on 5th November, of Professor Thomas Barlow Wood, Drapers Professor of Agriculture in the University of Cambridge. His death is not only a great loss to this College in which he was keenly interested as a member of its Governing Body, but also to his University and the whole world of agricultural science.

Professor Thomas Barlow Wood was born in 1869 and educated at the New Castle High School, Staffordshire, and Caius College, Cambridge. Soon after he graduated in Chemistry in 1889 there was a sudden demand by County Councils for teachers and lecturers in Agriculture and Agricultural Science. To meet this demand the late Professor Liveing advertised a course on Agricultural Chemistry which was organised by Henry Robinson and attended by Wood and others, some of whom have since become well known Agriculturists. In 1891, interest in the study of Agricultural Science was further stimulated by the allocation of whisky money to technical education and Wood secured an appointment as lecturer to the County of Devon. After spending a short time there he returned to Norfolk where he held a post which would now correspond to that of an Agricultural Organiser. In 1893 he was recalled by Liveing to Cambridge where his interests and energies have ever since been mainly confined to the organisation of what has become the present School of Agriculture. After serving under Somerville and Middleton he became its Director in 1907 in the capacity of Drapers Professor of Agriculture and the prestige which the present School holds reflects great credit on his leadership and happy collaboration with his colleagues and practical Agriculturists. Professor Wood will also be remembered for the valuable services which he rendered to the nation during the war. As an Agricultural Scientist of first rank he found time to lecture and to write books which will remain permanent and invaluable records of his activities in the sphere of research work in which he was particularly interested.

His visit to Trinidad last year will be remembered by many at this College, for "T.B.," as he was familiarly known always endeared himself to those who had the fortune to come into contact with him. He will be mourned by all his pupils, colleagues and friends, many of whom are scattered throughout the world. A reference to his death, an appreciation of his services and a message of condolence to his family have been recorded at recent meetings of the Governing Body, the Academic Board and the Advisory Committee of the College.

G. G.

COLLEGE NEWS.

Our thanks are due to Mr. D. MacDonald, B.Sc., A.I.C.T.A., of Bremersdup, Swaziland, for a consignment of Hluba Beans (*Voiandzeia subterranea*) and Teff Grass (*Eragrostis abyssinica*).

* * *

A meeting of the Trinidad Science Club was held on 28th November, when Mr. W. Scott gave a most interesting address illustrated by excellent films on "Java with special reference to its Sugar Industry." Another meeting of the Club was held on 2nd December, when Mr. C. E. Douglas of the Empire Marketing Board lectured on "Problems connected with the development of the Rice Industry."

* * *

We learn that Sir John Farmer, a Governor of the College, was nominated to represent the Imperial College of Science and Technology for a further period of four years as from September, 1929, and that the Hon. Gregor McGregor Peter, who is also a Governor of the College was nominated by the Governor of the Windward Islands to represent that Colony for the same period in succession to Mr. W. M. A. Steele.

* * *

The unofficial members of the Finance Committee of the Trinidad Legislative Council visited the College on 22nd November. The object of the visit was to give the Committee an opportunity of meeting members of the College Staff and of bringing them into touch with the various research activities of the College. The party which included the Hons. Sir Henry Alcazar, KT., Capt. A. A. Cipriani, F. Grant, A. B. Carr, S. Teelucksingh, Dr. A. H. McShine, C. H. Pierre, T. M. Kelshall, J. A. Biggart, L.A.P. O'Reilly, K.C., were afterwards entertained by the Principal.

* * *

Amongst recent visitors to the College were Messrs. F. C. T. Lord of the Colonial Sugar Refining Company, Fiji; E. S. Spragg of the Colonial Sugar Refining Company, New South Wales; T. Jackson, Agricultural Superintendent, St. Vincent; A. L Tichane, American Cyanamide Co., New York; J. B. Morrell, a Director of Rowntrees, York; R.Y. Rale, a representative of a well known shipping firm; Dr. C. A. Matley, Government Geologist, Jamaica; Col. H. M. Wallis of the Mount Royal Milling and Manufacturing Company Montreal; T. H. Stokes, British Guiana; Mrs. Nora A. Falcon, Hilton College, Natal; and Mrs. C. C. Guthrie.

A gratuitous specimen copy of *Tropical Agriculture* will be sent, post free, to any member of an agricultural society or to any other individual interested in tropical development on application to the Editor, *Tropical Agriculture*, The Imperial College of Tropical Agriculture, St. Augustine, Trinidad, B.W.I.

AGRICULTURAL EXCURSIONS.

A Field Excursion (to the eastern side of the colony) with the object of studying the Witch-Broom disease of cacao was organised for Wednesday, 20th November. The party consisted of several members of the Staff, the Post-graduates and some of the senior Diploma Students. Visits were first made to several estates in the Guanapo area which are now infected. One of these estates was most illustrative of the difficulties that the Trinidad Agricultural Department have to face, as being heavily mortgaged, the owner had apparently abandoned any serious attempts at cultivation, with the result that the whole area had become overgrown with bush. It was typical of many small holdings, which in this part present great difficulty, as it is obviously impossible for the Inspectors to do their duty efficiently. In a neighbouring estate, which was well cultivated, Witch-Broom was present, and the owner was endeavouring to cope with the disease, which, however, was probably spreading from semi-abandoned areas in the neighbourhood. Witch-broom in all its various stages was inspected. A visit was then made to the area recently acquired by the Government at Marper in the Plum Road area, where the disease was first notified some 18 months ago. Here the method of control was ably demonstrated by Mr. S. M. Gilbert, the Acting Director, and Mr. Foster his assistant who is in charge of the Witch-Broom campaign. It is too early yet to say how effective the present measures of control will prove adequate to stem the disease, but all were impressed by the efforts that are being made by the Trinidad Agricultural Department. Mr. Gilbert explained in detail the economic issue, which is a serious one, and the administration problems involved. The visit proved a most useful and instructive one to all members of the College party who are grateful to Mr. Gilbert and Mr. Foster for the thorough way in which the expedition was conducted.

On Monday, 25th November, a visit was paid to the annual stock show of the Usine Ste. Madeleine Sugar Co., at the invitation of Mr. G. B. Westwood, the General Manager. A fine show of estate cattle, buffaloes and mules were on exhibit and an opportunity was offered of seeing some of the best working cattle and stock in the colony. In spite of the inclement weather, an instructive day was spent and thanks are due to Mr. Westwood and his staff for their invitation and for their hospitality.

G. E.

The subscription to *Tropical Agriculture* is six shillings per annum, post free, Trinidad currency, to all countries within the British Empire or seven shillings, post free, Trinidad currency, to all other countries. Subscription can commence at any time during the year.

APPOINTMENTS.

The following appointments of Students in residence at the College during the session 1928-29 have been notified by the Secretary of State for the Colonies:—

Mr. W. Cook, Entomologist, Agricultural Department, Gold Coast.

Mr. J. Wright, Mycologist, Agricultural Department, Gold Coast.

Mr. A. V. Gibberd, Superintendent, Agricultural Department, Nigeria.

Mr. R. H. Fraser, Agricultural Officer, Northern Rhodesia.

Mr. B. J. Hartley, District Agricultural Officer, Tanganyika.

Mr. J. Robertson, District Agricultural Officer, Tanganyika.

Mr. F. R. Sanders, District Agricultural Officer, Tanganyika.

Mr. C. W. L. Fishlock, Agricultural Officer, Uganda.

VISIT OF SUGAR COMMISSION.

The members of the Sugar Commission that have been specially appointed by the Secretary of State for the Colonies to enquire into the causes of the existing depression of the sugar industry in these colonies made prolonged visits to the College on 5th December and 11th December. The Commission consists of Lord Olivier who is Chairman and Mr. D. M. Semple with Mr. S. Caine as Secretary. Mr. G. A. Jones, Assistant Commissioner of Agriculture at the Imperial College of Tropical Agriculture is also attached to the Commission under the special instructions of the Secretary of State. On the occasion of their first visit the Commission took evidence from the Principal and the senior members of the staff on the research activities of the College, more particularly in respect of sugar. During their second visit a more detailed and less formal inspection of this Institution was made. On both occasions the members of the Commission were the guests of the Principal.

REVIEW.

Studies on Cuban Insects.

[Published by the *Harvard University Press*, Cambridge, 1928, pp. 30. Price 3*s*. 6*d*].

This small volume from the Harvard Biological Laboratory and Botanical Garden in Cuba (Atkins Foundation) contains two papers based on studies of Cuban insects. The first of these is "Notes on Cuban and other West Indian Psammocharidae" by Nathan Banks, and the second is a paper entitled "Notes on Cuban Fulgoroid Homoptera," by J. G. Myers.

Both these papers deal almost entirely with taxinomic studies of the groups represented, and they form useful additions to the knowledge of these tropical insects.

H. A. B.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.):

	Foreign.		*Preferential.*	
	s.	d.	s.	d.
7th November ..	9	0	12	9
11th November ..	8	6	12	7½
14th November ..	8	6	12	7½
21st November ..	8	6	12	6
2nd December ..	8	4½	12	3
12th December ..	8	7½	11	9

The position may be summarised as follows from *C. Czarnikow's* latest reports: Sugar has passed through a further period of depression. New York "futures" were caught in the general depression experienced in speculative markets in America in the last week of October, confidence being considerably undermined by the weakness of the Coffee exchange as a result of the crisis in Brazil, whilst the serious slump in the American stock markets also led to some liquidation by outside interests.

Licht's second estimate of the European crop reveals that production is still 132,000 tons below last year's figures. Messrs. Willett and Gray's estimate of the world production represents a decrease of 381,000 tons. This is an encouraging item of news and even if a generous margin of error is allowed it would seem reasonable to assume that the growth of production for the time being has been checked. The extremely depressing conditions surrounding the article at present and the uncertainty of the immediate future, however, overshadows the market at the moment and any factor which might ultimately work in favour of sugar.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:—

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
11th Oct.	10·28	15·65	25·50	38·00	11·03-30·50
18th Oct.	9·94	15·70	25·50	38·00	25·00-27·62
25th Oct.	9·96	15·55	25·50	38·00	26·00-28·00
1st Nov.	9·88	15·10	25·50	38·00	9·50-30·00
8th Nov.	9·56	14·90	25·50	38·00	23·00-28·50
12th Nov.	9·46	14·95	25·50	38·00	· - ·
12th Dec. .... (local)	9·53	·	25 50	38·00	· - ·

In Liverpool the opinion with regard to the market is that prices of cotton have been unduly depressed through the agency of the heavy slump in the stock market in America and also through the continuous decline of the wheat markets. Actually, however, the situation has not shown much change. Egyptian prices have again suffered somewhat severely through forced liquidation and lack of genuine demand.

* * *

COCOA.—We give hereunder production and consumption figures in tons over a three-year period to 30th September:

	1928-29	**1927-28**	**1926-27**
Production	537,428	482,270	521,390
Consumption ..	518,754	476,478	470,184

Consumption for the year just ended can be considered satisfactory in comparison with the two previous years. On the other hand Production is uneven, and it is likely to be from year to year.

The market continues very uncertain and recent Stock Exchange slump has had a detrimental effect.

* * *

COFFEE.—On 16th November the *Times Trade and Engineering Supplement* stated "East Africa as a source of coffee supply to England has made very substantial progress in 1929. The first grade Kenya sort is sold out already for 1929 arrival and Uganda Robusta sells as soon as put on offer. West Indian and Brazilian sorts of coffee are cheaper than in October. The situation in Brazil is being watched with some anxiety.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:

	d.
31st October	9
2nd November	9½
7th November	8 5/16
12th November	7 13/16
14th November	8⅛
21st November	8 1/16
30th November	7⅞
6th December	7 15/16

The rubber market has been active but prices have mostly shown a declining tendency. The Dutch proposals, referred to in our last issue, for co-operation with the British in holding a certain quantity of rubber failed to have any stimulating effect on the market; the effect, if any, was rather the other way, the support so far pledged to the scheme being inadequate. The principal cause of weakness has been the severe break in the New York Stock Market which has been called upon to absorb very large quantities of rubber through speculative liquidation.

* * *

LIME PRODUCTS.—*Lime Oil.* The quantities of Handpressed now offering are neglected; the nominal quotation is 60s. per lb. Distilled is firm with further sales at 31s. per lb. c.i.f. *Lime Juice.* Concentrated is lower with sales at £20 c.i.f. for shipment. Raw is neglected. (*West India Committee Circular*, Nov. 14th.)